

# SERVICE MANUAL

# HAMMOND GRAND 100

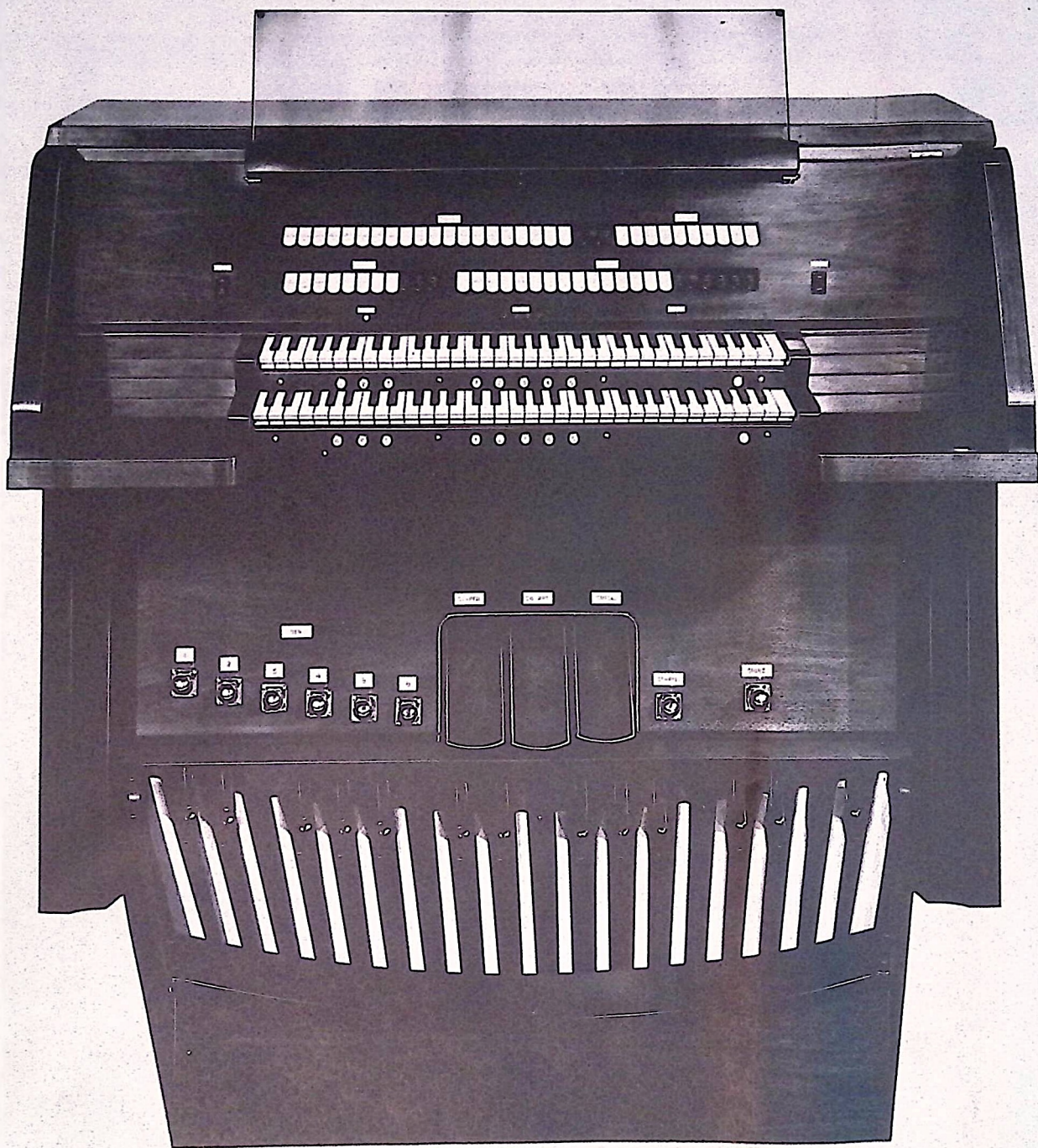
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Retro Sound Works



## TABLE OF CONTENTS

	<u>PAGE</u>		<u>PAGE</u>
GENERATOR	2	CHORUS & CELESTE SYSTEM	7
MANUAL KEYS RELAY ASSY.	2	REVERB. PREAMPLIFIER	8
COUPLER-MANUAL KEYBOARDS	3	EXPRESSION CONTROL	9
PEDAL SWITCH	3	POWER AMPLIFIER	9
HARP & CHIMES KEYS	4	BASS POWER AMPLIFIER	9
VOICE MESH	4	TREBLE POWER AMPLIFIER	9
STOP SWITCHING	5	POWER AMPLIFIER	9
CONSOLE OUTPUT AMPLIFIERS	7	SPEAKER SYSTEMS	9
VIBRATO SYSTEM	7	POWER SUPPLY	10

## LIST OF ILLUSTRATIONS

<u>FIGURE</u>		<u>PAGE</u>
1.	Block Diagram .....	11
2.	Schematic Diagram .....	12
3.	Console Wiring Diagram .....	13
4.	Generator Wiring (Sheet 1) .....	14
5.	Generator Wiring (Sheet 2) .....	15
6.	Console Output Amplifier Schematic .....	16
7.	Bus Wiring - Manual Relay Assembly .....	17
8.	System Wiring Diagram .....	17
9.	Wiring Diagram - Manual Relays.....	18
10.	Harp & Chimes Keyer Wiring.....	19
11.	Wiring Chart - Manual Relays .....	20
12.	Manual Bus Amp. Schematic .....	21
13.	Pedal Switch Wiring Chart .....	21
14.	Harp & Chimes Keyer Schematic .....	22
15.	Power Supply Schematic .....	22
16.	Pedal Voice Mesh Schematic .....	23
17.	Great Voice Mesh Schematic .....	23
18.	Pedal Bus Amp Schematic .....	24
19.	Tablet Preamp Schematic .....	24
20.	Swell & Antiphonal Voice Mesh Schematic.....	25
21.	Chorus- Celeste Schematic .....	26
22.	Vibrato Unit Schematic .....	27
23.	Intermediate Amplifier Schematic.....	28
24.	AO-59-1 - Dynakit (Power Amp) Schematic.....	29
25.	AO-58-1 - Dynakit (Power Amp) Schematic .....	30
26.	AO-59-1 - Monaural Output Amp Schematic .....	31
27.	AO-58-1 - Stereo Output Amp Schematic .....	31



**GENERATOR** - The tone wheel generator used in the Grand 100 is similar mechanically and electrically to the generators used in other models of Hammond organs. The generator furnishes 144 sine wave tones to the keying circuits. Ninety-six (96) of the tones produce the regular "tempered scale" fundamentals and harmonics as used in previous Hammond organs with the exception that tone numbers 92, 93, 94, 95 and 96 have not been included in the earlier models. The remaining forty-eight (48) tones, arbitrarily number 46½ to 93½, furnish the 7th and 11th harmonics which are not available from the tempered scale tone wheels. The 144 generated tones pass through filters on the generator cover to insure purity. The filtered sine wave tones are brought out to the terminal strip which is located on the back of the generator frame. The tone wheel generator is driven at constant speed by a self starting synchronous motor. There are three (3) cables attached to the generator terminal strip. These cables carry the generated tones to the manual keyer, the pedal switch and the harp-chimes keyer assembly.

**MANUAL KEYS RELAY ASSEMBLY** - The manual keys of the Grand 100 do not physically operate audio signal contacts. In most Hammond organs, the manual keys operate the audio signal contacts directly by depressing plastic actuators through which the contacts pass. The Grand 100 manuals are connected to relay coils and the armature of these relays actuate the audio signal contacts. The relay keying power is obtained from a heavy duty 14 volt D.C. supply located in the auxiliary rack. There are seventy-three (73) great manual relays and seventy-three (73) swell manual relays. Sixty-one (61) relays of each set normally actuate the lower five (5) octaves of the associated manual are known as the unison relays. The remaining twelve (12) relays of each set actuate the highest octaves of the associated manuals, only when the respective 4' couplers are used, and therefore, are referred to as the 4' extension. (See "Couplers")

Each great manual relay actuates sixteen (16) individual contacts. Fourteen (14) of these contacts carry the generated audio signals and, when actuated, connect the audio signals individually to the fourteen (14) great harmonic busses. The 15th contact of each great relay is used for keying of the harp. The 16th contact keys a D.C. voltage which is used as control intelligence for the great chorus circuitry in the auxiliary rack. Each swell manual relay actuates fifteen (15) individual contacts. The functions of these contacts are the same as the corresponding contacts in the great, except that there are no harp contacts in the swell. The generator tones are cables to terminals located in the center of the bottom of the manual keyer relay assembly. The generator tones are distributed from these terminals by specific lengths of resistance wire to the fourteen (14) rows of audio contacts for each manual. The specific wiring diagram and resistance values are indicated in Figure 10 in the schematic section.

When any manual relay is actuated, fourteen (14) audio circuits are completed, allowing the appropriate generated tones to appear on each of the fourteen (14) harmonic busses.\* The harmonic

busses collect the signals from the key contacts and feed them through band pass filters into individual bus amplifier circuits, which are located inside the manual keyer relay assembly. See Figure 6 in the schematic section. The harmonic bus bars for the eight (8) highest harmonics, 5th through 12th, are continuous, spanning the 73 note range of the relay assembly. These bus bars are connected to filters which pass the appropriate sine wave tones into the bus amplifiers, but attenuate all signals which are higher and lower in frequency than the desired harmonics. The six (6) lowest harmonics, which are, sub fundamental, sub 3rd, 2nd, 3rd, and 4th, in order, are collected on split busses, giving a high and low output for each harmonic. These busses are physically separated near their centers and separate electrical connections are made to each of the two sections of each bus. The high frequency and low frequency outputs from each harmonic bus are fed to separate band pass filters which are similar to the higher harmonic band pass filters, but are more selective since the desired pass band is smaller. The outputs of the high and low frequency filters for each harmonic are combined and amplified by a single transistor bus amplifier. There are, therefore fourteen (14) bus amplifiers for each manual. The outputs of these amplifiers are cabled to the voicing networks which are located behind the stop tablets.

The harp contacts in the great manual keyer are cabled to the harp keyer assembly which is located at the lower left side of the back of the console. The harp keying bus is at ground potential. The chorus control contacts in the great and swell manual keyers control the lighting of small bulbs in the chorus scanner assembly, which is located in the auxiliary rack. The voltages used to light the chorus control bulbs are obtained from a special regulate supply (power supply chassis) in the auxiliary rack. The common side of this supply is not grounded directly to the main organ ground, so the chorus control circuitry is "floating". For this reason, if any chorus control voltages are measured, they must be referred to the common terminal of this circuit in the auxiliary rack. See power supply schematic, Figure 14.

The relay magnets which operate the manual keying contacts are located on the top cover of the manual keyer relay assembly. The common side of all magnet coils is grounded to the negative side of the 14 volt keying supply. The positive side of the 14 volt supply feeds the great and swell keyboards. The key contacts in the keyboards are cabled to the relay magnet coils. Depressing any manual key completes the circuit from the power supply to the associated relay coil, actuating the audio signal contacts. An electrolytic capacitor and a silicon diode are wired in parallel with every magnet coil in the assembly. The capacitor and diode suppress sparks and mechanical noise of the keying magnets. Should replacement of a capacitor or diode become necessary, it is very important that polarity of the replacement is correct. If the polarity of a diode or capacitor is reversed, the component will be destroyed when the note is keyed, and subsequent damage to the silver key contact may result.

\*NOTE: SOME HARMONICS DO NOT RUN ALL THE WAY UP THE MANUALS SO THERE ARE LESS THAN FOURTEEN (14) TONES KEYED ON THE HIGHER NOTES.



**COUPLER - MANUAL KEYBOARDS** - There are twelve black tablets on the stop tab panel of the Grand 100. These tablets control key contact switching functions of the manual keys. The great and swell unison off tablets are not couplers in the strictest sense, but since their operation is similar to that of the couplers they may be considered as special couplers. The couplers produce no sound by themselves and must be used in conjunction with stop or voice tablets.

Physically the couplers in the Grand 100 consist of sets of key contacts which may be engaged, at the desire of the organist, to play notes from any particular key, which are different from the notes normally operated by that key. These sets of contacts are engaged or disengaged by means of electromagnets which are controlled directly from the coupler tablet switches. When a coupler is off, the 61 key contacts for that coupler are held in a neutral position where operation of the manual keys cannot cause electrical connection to be made to the coupler contacts. When the coupler is turned on all 61 contacts for that coupler are moved to a "ready" position, where operation of the manual keys causes electrical connection to be made to the coupler contacts. The contacts which key the organ when no couplers are in use are called "unison" contacts. In other words, if the coupler and unison off tablets were removed from the organ it would play as a standard or "unison" organ. It is difficult to explain the relationship between the various pitches of stops, the keys, the couplers, and the manual divisions of an organ in terms of the musical nomenclature of the stops. A much clearer explanation of these relationships can be made by considering only the keys and the relays which are operated by these keys. It is important to keep in mind that each relay for either manual completes all of the circuits necessary to produce any voice appearing on the stop tablets for that manual, regardless of the pitch.

If an organist ignores the coupler and unison off tablets, no matter what stops he uses, every key on the organ operates only one associated relay. For example, on the great manual, key #1 operates relay #1, key #2 operates relay #2, etc. of the great relays. Similarly, on the swell manual, key #1 operates relay #1, key #2 operates relay #2, etc., of the swell relays. This is the normal or unison operation of the organ. If the organist should depress the great to great 4' coupler tablet, every key on the great manual will now operate two relays. The unison relays operate as before, and, in addition, the great relay one octave higher will also operate. For example, on the great manual, key #1 operates relay #1 and relay #13. Key #2 operates relay #2 and relay #14, and etc. If the organist should additionally depress the great to great 16' coupler tablet, every key on the great, (with the exception of keys #1 to #12 as no sub octave relays have been provided for these keys) will operate three relays. Example: Key #13 operates relay #13, relay #25 and relay #1, of the great relays. At times, the organist may desire to play the 4' and 16' coupler notes without the unison notes and he may do this by operating the unison off tablet. The unison off, as previously mentioned, is similar to the couplers in operation, with the exception that it works in reverse of the couplers. Depressing the unison off tablet, energizes a magnet which pulls the unison contacts out of operation rather than pushing them into operation,

as the couplers do. The swell to swell 4' and swell 16' couplers perform the same function on the swell as the great couplers, already described. These couplers which provide only switching within the associated manual are called "INTERMANUAL" couplers. The other type of couplers found on the Grand 100 are "INTRAMANUAL" couplers. This type of coupler performs the same electrical function as the intermanual coupler, but the switching is done between the keys of one manual and the relays of the other. For example, if the swell to great 8' coupler is depressed and the great keys are operated, each great key will operate its regular unison relay and the corresponding relay in the swell relays. Great key #1 operates great relay #1 and swell relay #1, etc., specifically. If the swell to great 8' and 4' coupler tabs are depressed, great key #1 will operate great relay #1, swell relay #1 and swell relay #13. Note that the great keys ALWAYS OPERATE the great unison magnets UNLESS the great unison off tablet has been depressed. The swell to great 16' coupler works in a similar manner, but it brings in the swell relays an octave lower than the great unison relays.

The pedal coupler tablets perform the same function for the pedals as the intramanual couplers do for the great manual. If the great to pedal 8' tablet is depressed, pedal #1 operates great relay #1. If the swell to pedal 4' and swell to pedal 8' tablets are depressed, pedal #1 will operate swell relay #1 and swell relay #13. The regular pedal voices are not affected by the coupler tablets and may be used entirely independent of the couplers.

Some of the confusion about the footage numbers on the stop tablets and the footage numbers on the couplers may be cleared up if the following information is kept in mind. Conventionally, the footage numbers on coupler tablets relate only to the keying mechanism of the organ and not to the pitch of the voices.

Also, by convention, the NORMAL relationship between the keys and the actual keying devices, whether relays, pneumatics, tracker bars, or other is unison or 8'. The 8' nomenclature for couplers does not refer to pitch. It indicates only a unison or normal relationship between the keys and the keying mechanism. Some early theatre organs used the terms, sub-octave for the 16' coupler, and super-octave for the 4' coupler. These names more nearly describe the functions of the couplers, but they are not in common usage.

**PEDAL SWITCH** - There are 12 audio contacts per each of the 32 pedals in the G-100. The harmonics keyed directly for the pedal voices are; sub fundamental, fundamental, sub third, second, third, fourth, fifth, sixth, eighth, tenth, twelfth and sixteenth.

Each of the 32 pedals operates twelve audio contacts directly and the signals are collected by busses and carried to band pass filters in the same manner as the manual signals. Resistance wire length may be obtained from Figure 12 in the schematic section. The filtered outputs are then amplified by 12 individual transistor bus amplifiers. See Figure 17 in the schematics section for a circuit description.

The location of the pedal bus amplifiers is in the harp and chimes keyer assembly. After amplification, the 12 pedal signal outputs are cabled to the voice



## PEDAL SWITCH (CONTINUED)

mesh. Located just behind the termination panel of the console are three gang switches. These multiple contact switches activated by individual 12 V. D. C. relays (keyed by the stop tablet switches), electrically connect the three intramanual pedal couplers to their respective manual keyer circuits.

**HARP AND CHIMES KEYERS** - The harp-chimes keyer assembly is located at the lower left corner of the back of the console. The harp and chimes percussion voices are produced by keying combinations of sine waves with special transistor percussion keyers. Each of the transistor keyers has two inputs, one of which is a sine wave tone obtained directly from the tone wheel generator, and the other is the keying input which "fires" the keyer. When one of these keyers is keyed, it momentarily allows the sine wave tone to pass at full level, and then, slowly cuts it off again, regardless of whether the keying voltage is maintained or not. A true percussive effect is obtained in this manner, in contrast to that obtained with ordinary sustain type keyers where the key must be released to effect the sustained decay. For the harp effect, the keyers are keyed singly from the harp contacts in the great manual relay, at 8' pitch. Since the harp keying is obtained from the great manual relay, the harp is affected by the great intermanual couplers. The chime effect is produced by simultaneously keying five individual harp keyers when a single key is depressed. The chimes contacts are mounted on the underside of the great manual keys, so the couplers **DO NOT** affect the chimes keying. The keyin schedule for the chimes is determined by cross wiring which is located within the chimes contact strip, under the great manual. When any chimes key is depressed, a shorting bar electrically connects six contacts together. One of the contacts supplies the keying potential (which is ground in this case) and the other five contacts are wired to the various keyers. Normally, the harp and chimes contacts are not connected to the keyers. When the harp or chimes tablet is depressed, the appropriate connections are made by multiple contact gang switches located on the back of the harp-chimes keyer assembly. One of these gang switches connects the harp contacts in the great manual relays to the keyers, and the other connects the chimes contacts to the keyers. The resistors wired into the chimes gang switch circuit, at the switch, attenuate the keying level of the highest and lowest harmonic or tone for each chime note, for accurate synthesis of the chime sound.

**VOICE MESH** - The voice meshes receive the individual harmonic outputs from the 28 manual bus amplifiers and the 12 pedal bus amplifiers. These signals are connected to the tapping busses of the voice mesh assembly which is divided into four sections: Swell, Antiphonal, Great, and Pedal. If a playing key is depressed, the harmonic signals will be present at these tapping busses, regardless of whether a stop tablet is engaged or not. The Antiphonal portion of the tapping busses receives swell signals, and this, in effect, provides a third manual with its own voiced stops, and audio channels. The Antiphonal division is played from the Swell keyboard; Swell and Antiphonal divisions can be played simultaneously by engaging stops in each section and playing on the Swell keyboard. Traditionally, the Antiphonal voices are heard from the opposite end of

a building from the organ console, while the Great, Swell, and Pedal are located near the console.

Each of the harmonic signals appears at full level on the tapping busses, to which the groups of voicing resistors are connected. Eight different resistance values are utilized to control the levels at which the various harmonics appear at the outputs of the individual voice meshes. The loudness or strength of any particular voice or stop is determined by the ohmic value of the resistances connected to each bus bar of the busses selected to make up the voice. See Figures 15, 16, and 19 for identification of the particular resistors used to make up each of the 48 voices that are available.

The organ voices are now established. A wire connects each voice mesh composite signal to a tablet switch controlled from the front of the console by the stop tablets. Each stop tablet represents an individual bank of resistors on the voice mesh. In the **OFF** position of a stop tablet, the harmonics making up the voice are returned to ground.

Now, we list all stop tablet voices according to their general family for greater understanding later on in the text, and to help in servicing. The four general categories are Flute, Diapason, String, and Reed voices. In addition, there are Percussion, Compound voices, Intramanual, and Intermanual couplers operated by tablets and their associated switches.

Antiphonal (Played on Swell Manual)  
61 notes .... C to C5 (5 octaves)

Swell Manual  
61 notes .... C to C5 (5 octaves)

Great Manual  
61 notes .... C to C5 (5 octaves)

Pedal Keyboard  
32 notes .... C to G3 (3 octaves)

Chimes Keyboard (Played on Great Manual)  
25 notes .... G2 to G4 (2 octaves)

Harp Keyboard (Played on Great Manual)  
49 notes .... C2 to C5 (4 octaves)\*

\*NOTE: Intermanual (Great) couplers affect Harp Keyboard. Above 49 note range refers to unison pitch only.

### SWELL STOP LIST

### TYPE TO STOP

Geigen Diapason 16'	Diapason
Bourdon 16'	Flute
Diapason 8'	Diapason
Geigen Principal 8'	Diapason
Concert Flute 8'	Flute
Aeoline 8'	String
Dulciana Celeste II	2 Rank Diapason Celeste
Gamba 8'	String



## VOICE MESH (CONTINUED)

<u>SWELL STOP LIST</u>	<u>TYPE TO STOP</u>
Octave 4'	Flute
Nazard 2-2/3'	Diapason
Flautino 2'	Flute
Tierce 1-3/5'	Diapason
Larigot 1-1/3'	Diapason
Mixture III	3 Rank Compound
Vox Humana 8'	Reed
Oboe 8'	Reed
Clarinet 8'	Reed
Clarion 4'	Reed
Tremulant	Tremulant
Swell to Swell 16'	Intramanual Coupler
Swell Unison Off	Intramanual Coupler
Swell to Swell 4'	Intramanual Coupler

The above stops make up the swell organ.

<u>ANTI-PHONAL STOP LIST</u>	<u>TYPE OF STOP</u>
Open Diapason 8'	Diapason
Gedeckt 8'	Flute
Salicional 8'	String
Viola Da Gamba 8'	String
Gemshorn Celeste II	Diapason
Principal 4'	Diapason
Flauto D'Amore 4'	Flute
English Horn 8'	Reed
Trumpet 8'	Reed
Tremulant	Tremulant
Swell to Swell 16'	Intramanual Coupler
Swell Unison Off	Intramanual Coupler
Swell to Swell 4'	Intramanual Coupler

The above stops make up the Antiphonal organ.

<u>PEDAL STOP LIST</u>	<u>TYPE OF STOP</u>
Contra Bourdon 32'	Flute
Gedeckt 16'	Flute
Bourdon 16'	Flute
Violone 16'	String

## VOICE MESH (CONTINUED)

<u>PEDAL STOP LIST</u>	<u>TYPE OF STOP</u>
Principal 8'	Diapason
Gedeckt 8'	Flute
Super Octave 4'	Diapason
Bombarde 16'	Reed
Great to Pedal 8'	Intermanual Coupler
Swell to Pedal 8'	Intermanual Coupler
Swell to Pedal 4'	Intermanual Coupler

The above stops make up the Pedal organ.

<u>GREAT STOP LIST</u>	<u>TYPE OF STOP</u>
Bourdon 16'	Flute
Open Diapason 8'	Diapason
Melodia 8'	Flute
Gross Flute 8'	Flute
Dulciana 8'	Diapason
Cello 8'	String
Octave 4'	Diapason
Gedeckt 4'	Flute
Nazard 2-2/3'	Diapason
Fifteenth 2'	Diapason
Mixture IV	Compound 4 ranks
Trumpet 8'	Reed
Harp	Percussion
Chimes	Percussion
Tremulant	Tremulant
Great to Great 16'	Intramanual Coupler
Great Unison Off	Intramanual Coupler
Great to Great 4'	Intramanual Coupler
Swell to Great 16'	Intermanual Coupler
Swell to Great 8'	Intermanual Coupler
Swell to Great 4'	Intermanual Coupler

The above stops make up the Great organ.

**STOP SWITCHING** - After the organ voices are formed, as described above, an output wire from each voice mesh is connected to a voice tablet switch. The location of the voice tablet switches are immediately below the voice mesh assembly. Voice tab switches are opened and closed by the operation of the stop tablets through mechanical linkage.



## STOP SWITCHING (CONTINUED)

With the stop tablet in the OFF position, voice mesh signals are connected to ground. Those stop tablets which do not switch audio signals ON OR OFF, for instance, tremulants, couplers, harp, and chimes, operate their respective tablet switches for D. C. control switching.

Certain voices are NOT affected by the Crescendo-Sforzando switch. These voices are connected to ground by the appropriate voice tablet switches.

Those voices which ARE affected by the Crescendo-Sforzando switch, pass through the "off" contact of the appropriate voice tablet switch and on to the center pole of the Crescendo-Sforzando switch for that voice. The voice can then be switched ON OR OFF according to the action of the Crescendo Pedal or the Sforzando pistons (thumb or toe).

A particular voice can continue to an output channel from EITHER a voice tablet switch or a Crescendo-Sforzando switch since, the same voices are connected by a jumper wire.

The Crescendo or Sforzando switches do not physically operate the stop tablets.

One other effect is obtained from the Crescendo switch. There is a solenoid connected to the switch bar which can instantaneously turn on all of the Crescendo switches plus two couplers, which do not appear in the Crescendo, as operated by the pedal. This device is called "Sforzando" and is operated by the Sforzando reversible pistons, both thumb and toe. A "Reversible" piston turns the device on with one push and turns it off with another push. The thumb piston is located at the extreme right and just below the Swell keyboard. The toe piston is located to the far right of the knee board.

Not all voices and couplers are affected by the Crescendo and Sforzando devices. The following list of functions makes up the Crescendo sequence. These functions are listed in order of operation.\* Four green indicator lights are lighted to indicate approximate position of the Crescendo pedal, as the pedal is depressed. One red light indicates when the Sforzando is engaged.

\*NOTE: (Looking at rear of Console at switch from left to right.)

Crescendo light #1	Swell Aeoline 8'
Great Melodia 8'	Pedal Bourdon 16'
Swell Concert Flute 8'	Great Dulciana 8'
Swell Chorus Control See later section on chorus generator control	Great Chorus Control See later section on chorus generator control
Pedal Chorus Control See later section on chorus Generator control	Swell Gedeckt 4'
Great Gedeckt 4'	Pedal Gedeckt 8'
Crescendo light #2	Swell Diapason 8'
Great Octave 4'	Swell-to Swell 4' Coupler

## STOP SWITCHING (CONTINUED)

Swell Nazard 2-2/3'	Great Cello 8'
Swell Gamba 8'	Great Cross Flute 8'
Pedal Super Octave 4'	Great-to-Great 4' Coupler
Swell Octave 4'	Great Open Diapason 8'
Crescendo Light #3	Pedal Gedeckt 16'
Swell Clarinet 8'	Great Mixture IV
Pedal Violone 16'	Great Nazard 2-2/3'
Swell Mixture III	Swell-To-Swell 16' Coupler
Great Trumpet 8'	Crescendo Light #4
Swell-To-Pedal 8' Coupler	Pedal Bombarde 16'
Swell-to-Great 4' Coupler	Swell-To-Great 8' Coupler

The last two couplers are activated by the Sforzando Solenoid, but not by the Crescendo pedal. The Sforzando Solenoid is operated by a reversible switch and does not affect the 4 green Crescendo lights.

In total, there are 65 voice tablet switches; 34 switches are double-pole double-throw and 31 switches are single-pole single-throw.

Thirty-two(32) of the DPDT switches are for the series connected pairs of stop tablets which activate chorus control lamps. See schematic Figure 2 for identification of the tablet pairs. The reason for the paired voices being used is to simulate the pipe organ effect of one rank of pipes beating against another. The remaining two DPDT switches are the Great and Swell Tremulants which control narrow and wide vibrato channels with the non-vibrato channels.

For reference we now list those voice tablet switches in each category.

### GRAND 100 VOICE TABLET SWITCHES

<u>SPST AO-29019</u>	<u>DPDT AO-29018</u>
Swell-to-Great 4' (Gt.)	Trumpet 8' (Ant.)
Tremulant (Ant.)	English Horn 8' (Ant)
Swell-to-Great 8' (Gt.)	Flauto D'Amore 4' (Ant.)
Swell-to-Great 16' (Gt.)	Principal 4' (Ant.)
Great-to-Great 4' (Gt.)	Tremulant (Gt.)
Great Unison Off (Gt.)	Salicional 8' (Ant.)
Great-to-Great 16' (Gt.)	Gedeckt 8' (Ant.)
Gemshorn Celeste II (Ant.)	Open Diapason 8' (Ant.)
Chimes (Gt.)	Gedeckt 4' (Gt.)
Harp (Gt.)	Tremulant (Sw.)
Trumpet 8' (Gt.)	Octave 4' (Gt.)
Mixture IV (Gt.)	Clarion 4' (Sw.)



# GRAND 100 VOICE TABLET SWITCHES (CONTINUED)

## SPST AO-29019

Swell-to-Swell 4' (Sw.)	Cello 8' (Gt.)
Fifteenth 2' (Gt.)	Clarinet 8' (Sw.)
Swell Unison Off (Sw.)	Dulciana 8' (Gt.)
Nazard 2-2/3' (Gt.)	Oboe 8' (Sw.)
Swell-to-Swell 16' (Sw.)	Vox Humana 8' (Sw.)
Gross Flute 8' (Gt.)	Melodia 8' (Gt.)
Mixture III (Sw.)	Open Diapason 8' (Gt.)
Larigot 1-1/3' (Sw.)	Gedeckt 4' (Sw.)
Bourdon 16' (Gt.)	Octave 4' (Sw.)
Tierce 1-3/5' (Sw.)	Trompette 8' (Ped.)
Flautino 2' (Sw.)	Gamba 8' (Sw.)
Swell-to-Pedal 4' (Ped.)	Gedeckt 8' (Ped.)
Nazard 2-2/3' (Sw.)	Aeoline 8' (Sw.)
Swell-To-Pedal 8' (Ped.)	Principal 8' (Ped.)
Great-to-Pedal 8' (Ped.)	Violone 16' (Ped.)
Super Octave 4' (Ped.)	Geigen Principal 8' (Sw.)
Dulciana Celeste II (Sw.)	Diapason 8' (Sw.)
Concert Flute 8' (Sw.)	Gedeckt 16' (Ped.)
Bourdon 16' (Ped.)	Bourdon 16' (Sw.)
	Countra Bourdon 32' (Ped.)
	Geigen Diapason 16' (Sw.)
	Viola Da Gamba 8' (Ant.)

## CONSOLE OUTPUT AMPLIFIERS

The outputs of the tab preamplifiers are the inputs to the next stage of amplification. Here, the channelled signals are boosted to a level strong enough to leave the console, enter the auxiliary rack and drive the vibrato delay lines. This nine-channel amplifier employs the only vacuum tubes in the console. Eight of the nine inputs are from the tab preamplifiers and the ninth input is from the harp and chimes keyer.

See Figure 23 for a schematic of the console output amplifier in the schematic section.

After amplification, the channels which are affected by the tremulant tablets, deliver their signals back to the voice tablet switch assembly where the switching is effected. If the tremulant tablets are engaged, the signals are sent to the appropriate vibrato channel. If the tremulant tablets are not engaged, the switch will deliver the signals to the associate non-vibrato channel.

On leaving the console then, there are twelve channels

# CONSOLE OUTPUT AMPLIFIERS (CONTINUED)

present at the terminaiton panel:

Term. Number 25 (Blk-Yel)	Pedal
Term. Number 16 (Grn)	Great Wide Vibrato
Term. Number 14 (Yel.)	Great Narrow Vibrato
Term. Number 9 (Brn.)	Great Non-Vibrato
Term. Number 19 (Gray)	Swell Wide Vibrato
Term. Number 18 (Blu)	Swell Narrow Vibrato
Term. Number 11 (Red)	Swell Non-Vibrato
Term. Number 28 (Blk-Blu)	Swell Celeste
Term. Number 21 (Blk-Red)	Antiphonal Vibrato
Term. Number 26 (Blk-Gn.)	Antiphonal Celeste
Term. Number 12 (Orn)	Antiphonal Non-Vibrato
Term. Number 23 (Blk-Orn)	Harp-Chimes

## VIBRATO SYSTEM

The last of the twelve channels coming to the rack is #23, the Harp-Chimes signals. This information is fed into the Great audio channel where it combines with Great signals and receives the same phase shifting and expression treatment as the Great signals.

There are special features in the vibrato system which are unique to the Grand-100 organ.

The first notable feature of the vibrato system is the application of vibrato rates which are different for the Great, Swell and Antiphonal divisions. The vibrato scanners are all driven from one synchronous motor by a belt and pulley system. Different rates for the scanners are obtained by using drive pulleys of different diameters. The vibrato speeds are 5.5 (Swell), 6.0 (Ant.), and 6.5 (Great) cps. respectively. These speeds more closely approximate the speeds found in church pipe organs and they are slower than on some other Hammond organs.

The second feature of the vibrato system is the application of different widths of vibrato, available from the different sized delay lines described above. An organist may, for instance, use the 8' Gross Flute Stop, which receives wide vibrato, and the 8' open Diapason stop, which receives narrow vibrato, simultaneously on the Great Manual. Again, this treatment follows pipe organ practice for greater authenticity. The Antiphonal Division uses only one medium width of vibrato.

The third feature of the vibrato system is the addition of a carefully determined amount of tremolo to each of the vibrato sections. Organ pipe output was subtled under conditions of varying air pressure such as produced by the pipe organ.

## CHORUS AND CELESTE SYSTEM

The abbreviation LDR means "light dependent resistor". The general term, "photo-cell" refers to any one of a number of devices which are sensitive to light. Generally, a photo-cell is a photo-voltaic device which will



## CHORUS & CELESTE SYSTEM (CONTINUED)

produce a measurable voltage across its terminals when it is exposed to light. The light dependent resistors which are used in the Grand 100 are NOT photovoltaic and will produce no voltage across their terminals when exposed to light. If an external voltage is impressed across the terminals of a light dependent resistor, the amount of current which will flow through the LDR depends on the intensity of the light falling on its surface, and the current may be controlled by varying the intensity of the light. In effect, the RESISTANCE of the LDR varies with illumination, and for this reason the LDR is a PHOTORESISTIVE device. However, LDR's are commonly referred to as photocells, so this term will be used in the discussions.

The Grand 100 organ makes use of these solid state devices in the Chorus-Celeste generator and the expression control circuits.

The Chorus-Celeste generator located in the Auxiliary Rack just above the power supply chassis has six signal inputs (See Figure 20-Schematic Section). Eleven 12AU7 tubes are used; (dual triode tube), five triode sections are used as amplifiers, and sixteen triode sections are used as phase shifters, containing LDR's on the cathodes of each respective triode section.

A 12 RPM synchronous motor, powered from the AC supply, is mounted on the Chorus chassis and drives a glass disc with a black coating on which openings are etched. Nine tungsten filament light bulbs are mounted on the chassis in such a way so as to shine through the openings in the disc. See Figure 20 for a diagram of the circuitry which controls the brightness of the light bulbs.

You will note from the diagram, that manual keys and selected combinations of stops on the organ, as they are activated, increase the brightness of the respective light bulb for the Chorus circuit involved. The effect is additive as more keys and stops are used.

The light bulbs shine through the rotating openings in the disc on to the sensitive surface of the LDR's connected to the cathode side of the phase shifters. The amount of light falling on the sensitive side of the photocell determines the degree of phase shift. The rate at which the intensity of light is varied directly controls the CHANGE of degree of phase shift. The circuit is designed so that when no light falls on the photocell, the LDR resistance is about 1 megohm; and there is no appreciable phase shift at the output. With partial light, the resistance is about 40,000 ohms; with high light, the resistance is about 5,000 ohms and the phase shift is maximum. Note that the two parameters referred to above are the brightness of a bulb and the position of the opening in the disc in relation to the bulb.

The chorus and celeste effects in a pipe organ depend on the same kind of variables as does the Hammond Grand 100; the more pipes that are activated, the more chorus effect takes place; the more of the Grand 100 keys and stops that are activated, the more chorus takes place.

## CHORUS & CELESTE SYSTEM (CONTINUED)

The different audio channels, high, mid, and low pass filter circuits are shifted at fast, medium, and slow rates of change to produce authentic pipe organ effects. These chorus rates are obtained from the design of the scanning disc by incorporating different numbers of slots in each track. Therefore, Pedal chorus: 0.6 cps (3 openings), slow chorus (low pass): 0.8 cps (4 openings), medium chorus (mid pass): 1.0 cps (5 openings), fast chorus (high pass): 1.4 cps (7 openings). The outer two tracks are the celeste openings and are 1.8 cps and 2.2 cps (9 and 11 openings), respectively. The celeste channels operate in much the same manner as the chorus, except the light bulbs remain at full brilliance at all times.

The brightness of the chorus phase shifter lamps is controlled separately for the Great, Swell, and Pedal divisions. The filament current for the swell shifter lights comes from any or all of three separate paths. In the swell manual relays, one row of relay operated contacts, supplies current to the output bus through 100 ohm resistors on each contact. The inputs of all the resistors are bussed to a regulated 7 volt DC supply (from power supply chassis). Then, as more and more keys are depressed, the current passing into the output bus increases by virtue of paralleling the resistors. The output bus is wired directly to the chorus lamps for the swell voices. (Antiphonal voices use the same lamps, but different photocells). Certain pairs of stop tablets in the swell division are wired so that when both stops of any pair are engaged, another current path through a 47 ohm resistor is connected from the DC supply voltage to the respective chorus lamps. This current, then, is additive to any supplied from the manual relays, and to any from other pairs of stops in similar use. See Figure 2 in the schematic section for the paired stops which are connected to the 47 ohm resistors. The third path for current to the shifter chorus lamps is through a contact on the crescendo switch, which also has a 47 ohm resistor in series with the supply voltage. The Great shifter lamps are supplied current from similar manual relay key contacts, pairs of stops, and a crescendo contact. Provision has also been made to light the Great chorus shifter lamps to almost full brilliance when the Chimes stop tablet is operated, since the chorus effect greatly enhances the chime tones.

The pedal chorus lamp is controlled only by the pedal stop tablets and one contact of the crescendo switch. Certain combinations of two similar toned pedal stops turn the pedal chorus lamp on to full brilliance, and the crescendo switch contacts have a single 47 ohm resistor in series for partial lighting of the lamp.

## REVERBERATION PREAMPLIFIER

Three 12BH7 tubes and three chokes, plus other components, amplify the signals to drive the reverberation units. The function of the choke on the plate side of the tube is to provide constant current drive.

Three inputs become the reverb, drive channels: Antiphonal B #79, Swell B #77, and Great B #74. The actual connections to the three identical reverb, units are Antiphonal Reverb. Drive #73, Swell Reverb. Drive #72, and Great Reverb. Drive #71. These audio drive signals plug into the input jacks of the reverb. units. The outputs of the reverb. units return to the Inter-



## REVERBERATION PREAMPLIFIER

mediate Amplifier as: Antiphonal Reverb. Input #62, Swell Reverb. Input #63, and Great Reverb. Input #64. Obviously, inputs and outputs must belong to the same division or channel.

The three reverberated signals are now amplified by the three preamps which have not been used of the Intermediate Amplifier namely, Antiphonal: V1316 and V1317, Swell: V1311 and V1312, and Great: V1305 and V1306. (Left side of Intermediate amplifier).

The A and B channels now merge at the potentiometers that are ganged together and which control the gain, tone, and reverberation levels. Finally, the signals go to the power amplifiers and out to the speaker systems.

## EXPRESSION CONTROL

Each of the two console expression pedals (Great-Pedal and Swell-Antiphonal) is equipped with a potentiometer to which three wires are connected. The composite six wire cable is connected to the rack power supply and the expression control circuits at the intermediate amplifier.

The power supply delivers a regulated 7 V.D.C. potential. As the expression pedal is depressed, the resistance of the circuit changes, affecting the brightness of light bulbs in various encapsulated light dependent resistors, resembling plug-in crystals, located at the Intermediate Amplifier.

Seven channels are controlled by the two expression pedals. The Great-Pedal (expression pedal) controls the pedal, Great A, and Great B channels; the Swell-Antiphonal expression pedal controls the Swell A, Swell B, Ant. A, and Ant. B channels. Each LDR is matched with a 5% resistor and the two multi-channel groups are matched at the factory for equal tracking. Then, the factory recommends that in the event of a defective LDR, replace the 3 and 4 LDR's with their matching resistors to retain the tracking characteristics as when new.

See Figure 22 in the schematic section for the circuit locations of the 7 LDR's. As with the Chorus-Celeste LDR's, the brightness of the light bulbs shining on the photo-conductive cells determines the resistance of the circuits.

## POWER AMPLIFIERS

The Grand 100 uses two types of power amplifiers; bass AO-59, 70 watts (Music Power Rating) for the Pedal division, and treble AO-58, 85 watts total (Music Power Rating) for the Swell, Antiphonal, and Great divisions.

## BASS MONAURAL POWER AMP.

Two types of amplifiers are used which are interchangeable; namely, the Dynakit and the Rauland-Borg. See the individual schematics for the circuit details of each unit.

The amplifier uses a pentode voltage amplifier (6AN8) directly coupled to a cathode phase inverter. A capacitive feedback loop is employed for high frequency compensation which also correct the inherent unbalance of this type of phase inverter. The two, push-pull output tubes (KT88) are operated with fixed bias and

## BASS MONAURAL POWER AMP (CONTINUED)

are driven by the inverter. The load impedance is comparatively uncritical due to the small percentage of screen loading which improves the regulation of the stage. Phase compensation is provided across the entire frequency band and eliminates any tendency towards motor boating or oscillation.

The full wave rectifier employed is a (GZ34, 7Z34 or 5AR4) tube. It is recommended that the output tubes be replaced by a matched set for maximum efficiency.

The Dynakit amplifier, only, is a commercial model and contains an external pre-amplifier multi-connector which, for our purposes, is not used. The silicon rectifier used in the Rauland-Borg power supply can be replaced with the silicon diode of the Dynakit amplifier. See the semi-conductor parts list for the commercial number of the diode.

## TREBLE STEREO POWER AMPLIFIER

As with the bass amplifier above, two different manufacturers have been used, but the two makes are interchangeable. See the schematic diagrams for the minor circuit differences of each amplifier.

The two non-interacting channels of the stereo amplifier provide the power for the loud speakers with great efficiency. The high power capacity and low internal impedance provide excellent damping for the Grand 100 quality speaker systems without need to make adjustments to match specific installations. The amplifier does not exhibit bounce and flutter when pulsed with a transient signal. Thus, a sharp percussive signal will be reproduced with sharpness and clarity with neither overhang nor muddiness. The power handling capabilities are maintained over the entire audio band without the sharp rise in distortion which characterizes most amplifiers at the extremes of high and low frequencies.

The 7199 tube is used as a pentode high gain voltage amplifier directly coupled to a cathodyne phase inverter. This type of phase inverter has the unique advantage that its operation is independent of tube aging, so that no adjustments are necessary for maintaining optimum performance.

## POWER AMPLIFIERS

The internal capacitive feedback loop provides accurately balanced driving signals to the output tubes and balances the phase inverter. These output tubes are type EL34/6CA7; one pair for each channel. The connection of the output tubes includes a small percentage of screen grid loading which improves the regulation and makes the tubes comparatively uncritical of load impedance. The use of a minimum number of phase shifting stages, along with careful transformer design, makes the amplifier stable at all frequencies. This feature allows no tendency toward oscillation or motor-boating under any condition.

## SPEAKER SYSTEMS

The Grand 100 standard complement includes one bass and three treble speaker cabinets. The three treble speaker systems are identical.

The bass or pedal speaker cabinet contains one 15", heavy duty speaker of 8 ohms impedance. The special enclosure is a ported, bass reflex type. The function



## SPEAKER SYSTEMS (CONTINUED)

of this speaker system is to produce sounds in the approximate frequency range of 32 to 200 cycles. This speaker is driven by the pedal power amplifier with its 70 watts (music power output rating).

The treble speaker cabinets each contain two channels. Each channel is made up of two (2) 12", 16 ohm speakers which are connected in parallel so that the 8 ohm tap may be used on the power amplifier. Each set of two speakers, then, is made up of a high and low frequency response type which overlap considerably. No crossover network is used for the pair of speakers since the overlapping is a design characteristic. The pair of treble speakers comprise either an "A" or a "B" channel. The approximate response of a low frequency speaker is 30 to 3000 cycles; that of the high frequency speaker is approximately 75 to 6000 cycles. See the installation manual for the dimensions and weights of each type of speaker cabinet, as well as recommendations on cabinet placement. Also, refer to this manual for specifications on larger speaker and amplifier complements.

The design of the power and speaker systems is such that overload will occur in the power amplifiers before the speaker system will distort.

## POWER SUPPLY

The power supply assembly is comprised of three major divisions. The high voltage transformer supplies the plate voltage for all tubes with the exception of those in the power amplifiers. The voltage supplied is 280 volts. In addition, another winding of this transformer supplies the 25 volts for all transistor requirements. One further supply is derived from this transformer, that of the -4 volts which is used to control the harp and chimes keyers.

A second transformer supplies all filament requirements for the tubes, again, with the exception of the power amplifier tubes.

The third transformer is a low voltage type which supplies all of the 12 volt operated relays and solenoids with a 14 volt heavy duty supply as well as a regulate 7 volt supply for the expression control circuits and the chorus-celeste lamps.









**PAGE 11**

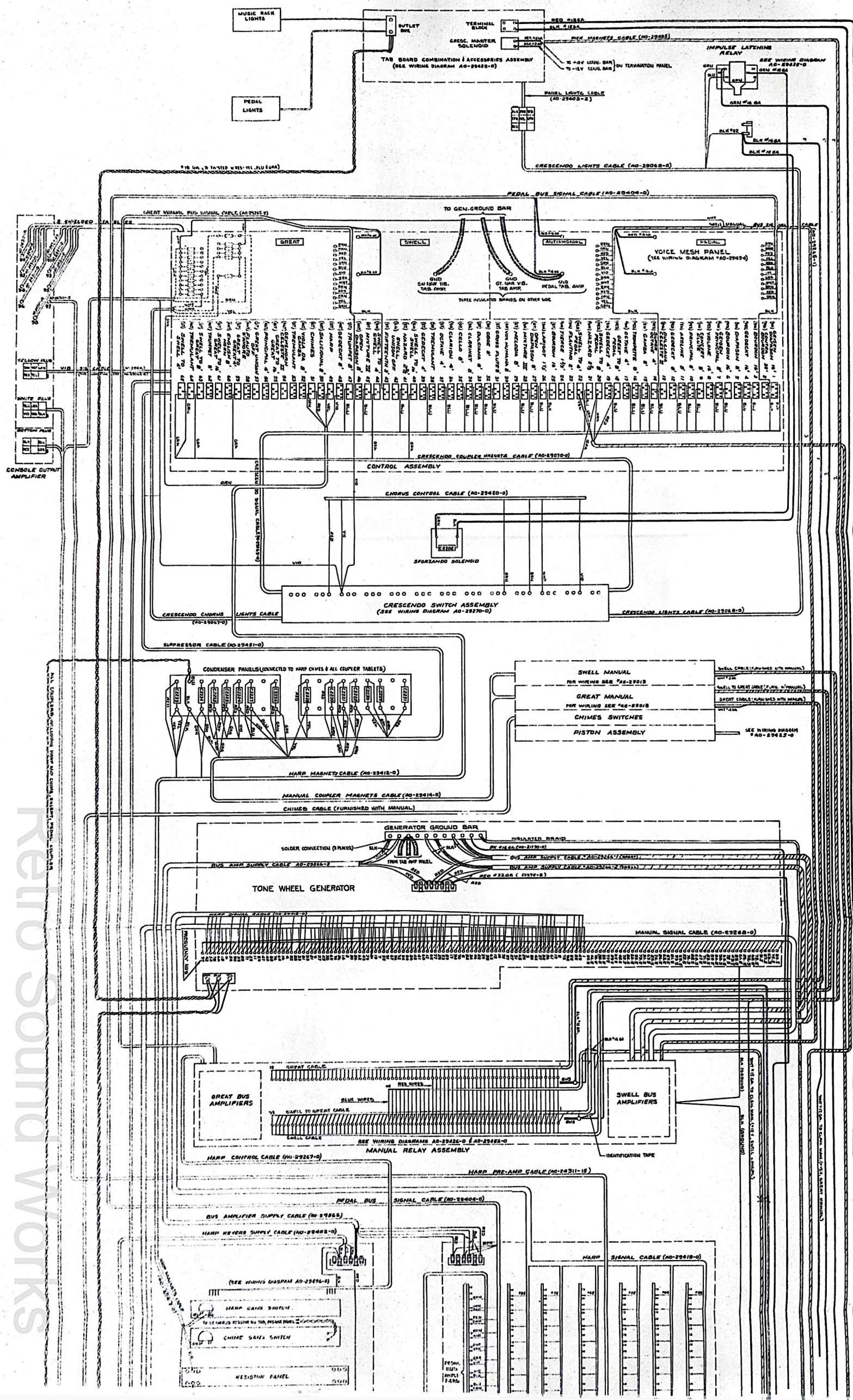












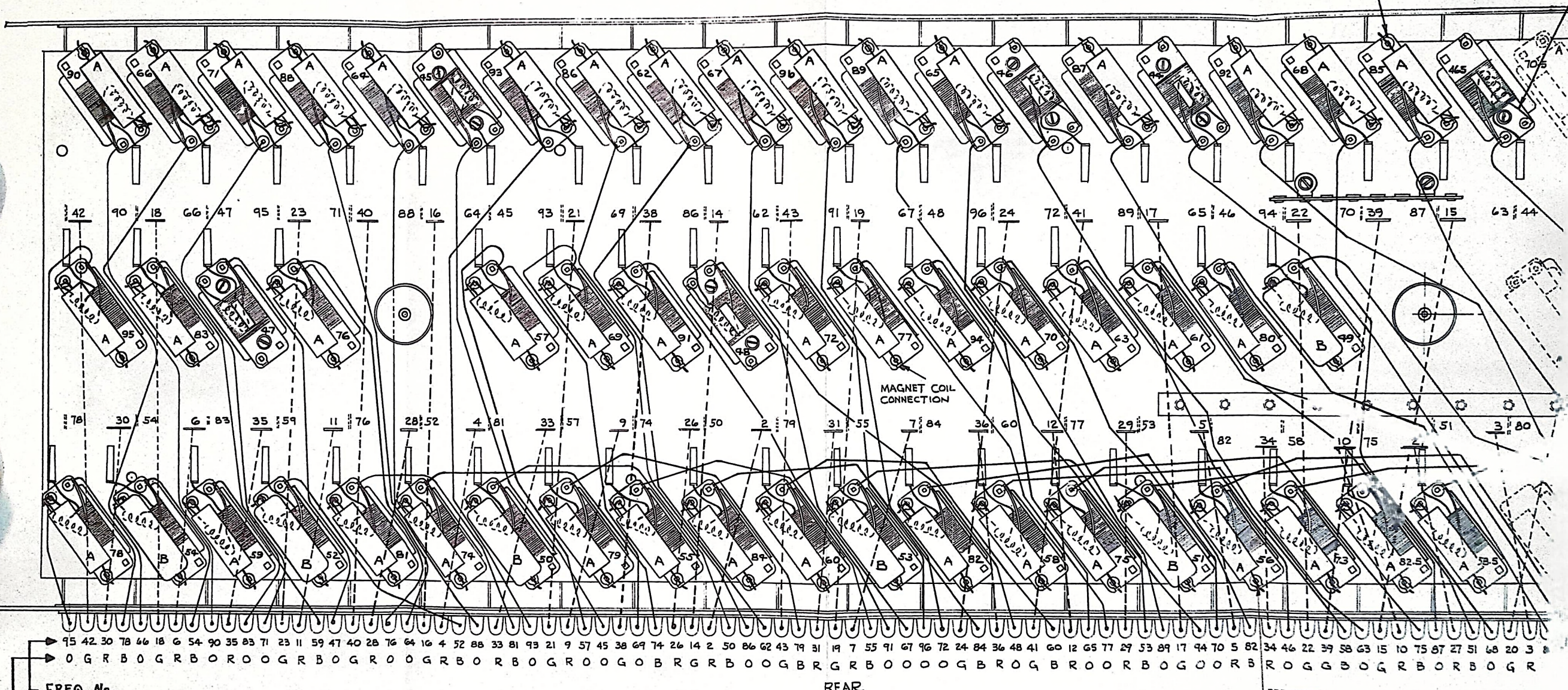






SEE NOTE:  
MAGNET COIL CONNECTION WHEN  
USED WITH TRANSFORMER

FRONT



MAGNET COIL  
CONNECTION

SEE NOTE:  
MAGNET COIL CONNECTION

NOTE:

SEE DRAWING AO-  
SEE DRAWING AO-  
LEAD FROM MAG-  
LEAD TERMINAL

FREQ. No.  
LEAD COLOR

Code  
B= BROWN  
R= RED  
O= ORANGE  
G= GREEN

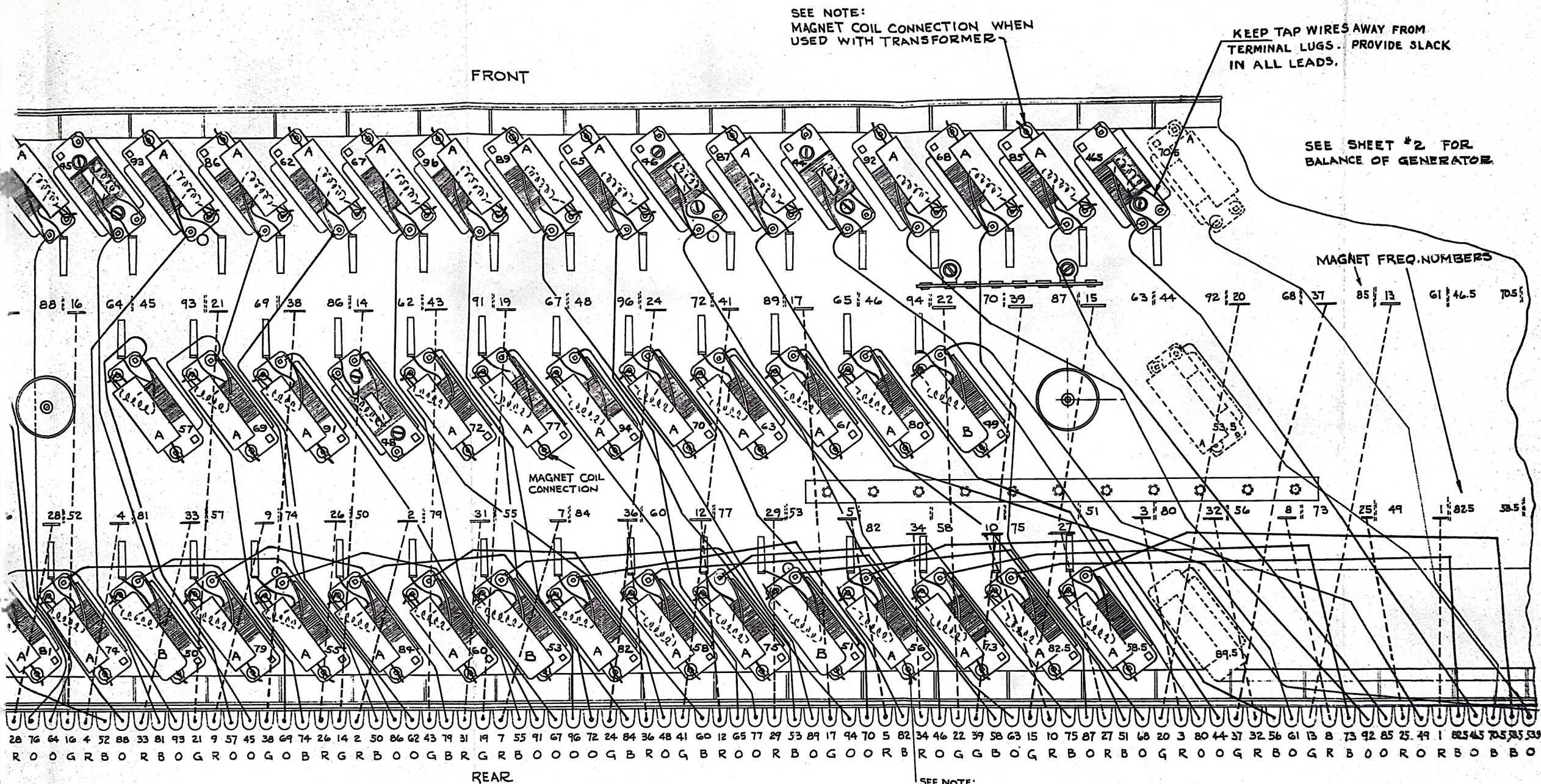
GREEN LEADS TO RUN PARALLEL TO ADJACENT BEARING PLATE AS FAR AS REAR EDGE OF GENERATOR COVER  
ALL ORANGE LEADS TO FOLLOW A DIRECT COURSE FROM COILS TO TERMINALS AS POSSIBLE. ORANGE LEADS TO RUN ABOVE BROWN LEADS IN DRESSING TO TERMINALS.

CONDENSER	PART NUMBER
"A"	AO-506-13
"B"	AO-506-18

FOR SELECTION OF ALL CONDENSERS, SEE IN-21680

FIGURE 4 GENERATOR WIRING SHEET 1





JACENT BEARING PLATE AS FAR  
COVER  
ECT COURSE FROM COILS TO  
S TO RUN ABOVE BROWN LEADS

Retro Sound Works



SEE NOTE,  
MAGNET COIL

FRONT

SEE SHEET  
# 1 FOR BALANCE  
OF GENERATOR

TERMINAL FOR FREQ. N°  
COLOR OF LEAD WIRE

CODE  
B = BROWN  
R = RED  
O = ORANGE  
G = GREEN

GREEN LEADS TO RUN PARALLEL TO ADJACENT  
BEARING PLATE AS FAR AS REAR EDGE OF  
GENERATOR COVER

ALL ORANGE LEADS TO FOLLOW A DIRECT COURSE FROM  
COILS TO TERMINALS AS POSSIBLE. ORANGE LEADS  
TO RUN ABOVE BROWN LEADS IN DRESSING TO  
TERMINALS.

REAR

NOTE:

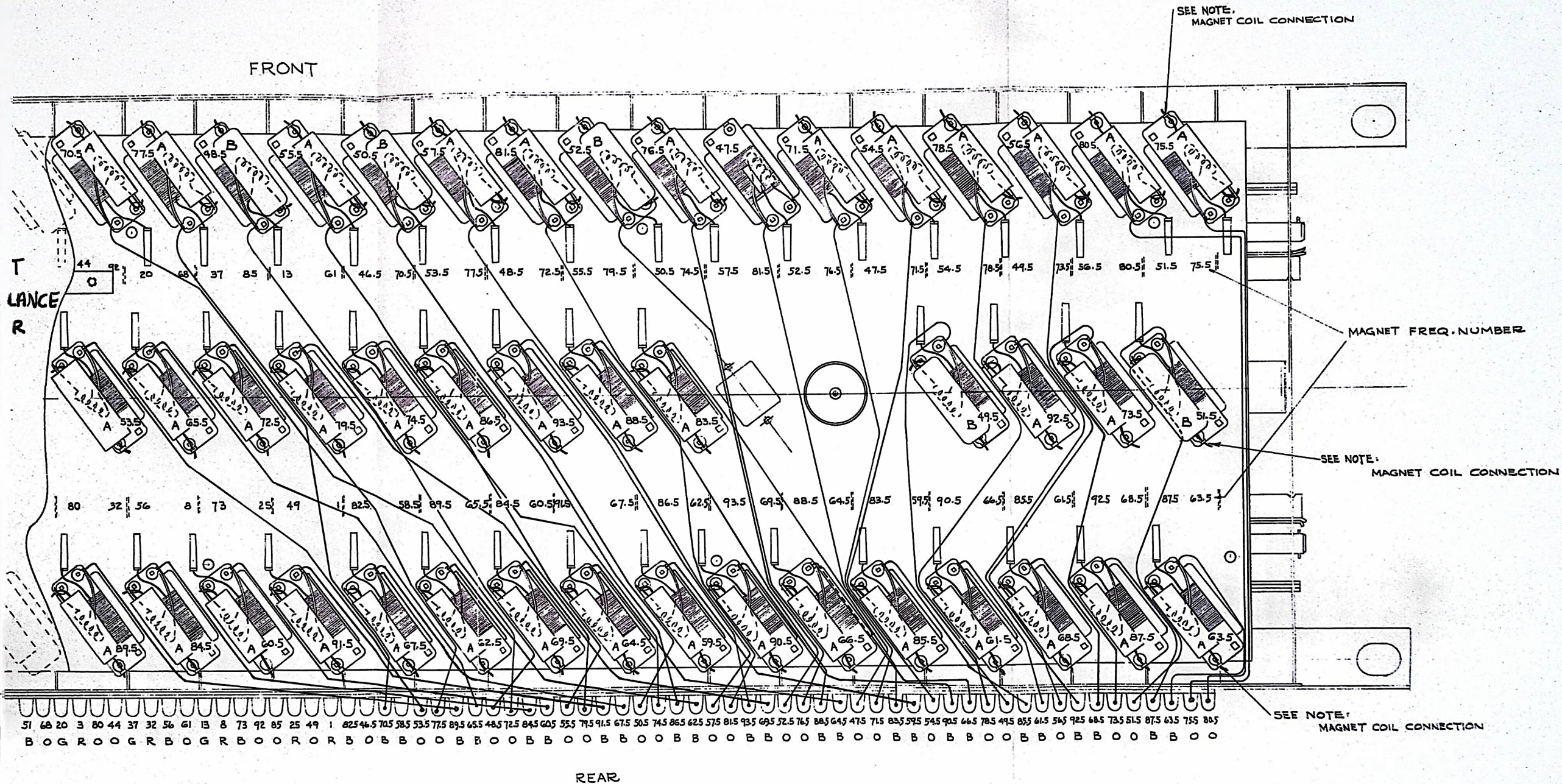
SEE DRAWING AO-29127-O FOR M  
SEE DRAWING AO-29128-O FOR M

\* LEAD FROM MAGNET COIL TO CO  
LEAD TERMINAL AS NOTED

Retro Sound Works

FIGURE





GREEN LEADS TO RUN PARALLEL TO ADJACENT BEARING PLATE AS FAR AS REAR EDGE OF GENERATOR COVER

ALL ORANGE LEADS TO FOLLOW A DIRECT COURSE FROM COILS TO TERMINALS AS POSSIBLE. ORANGE LEADS TO RUN ABOVE BROWN LEADS IN DRESSING TO TERMINALS.

NOTE:

SEE DRAWING AO-29127-O FOR MAGNET LOCATION (FRONT)  
SEE DRAWING AO-29128-O FOR MAGNET LOCATION (REAR)

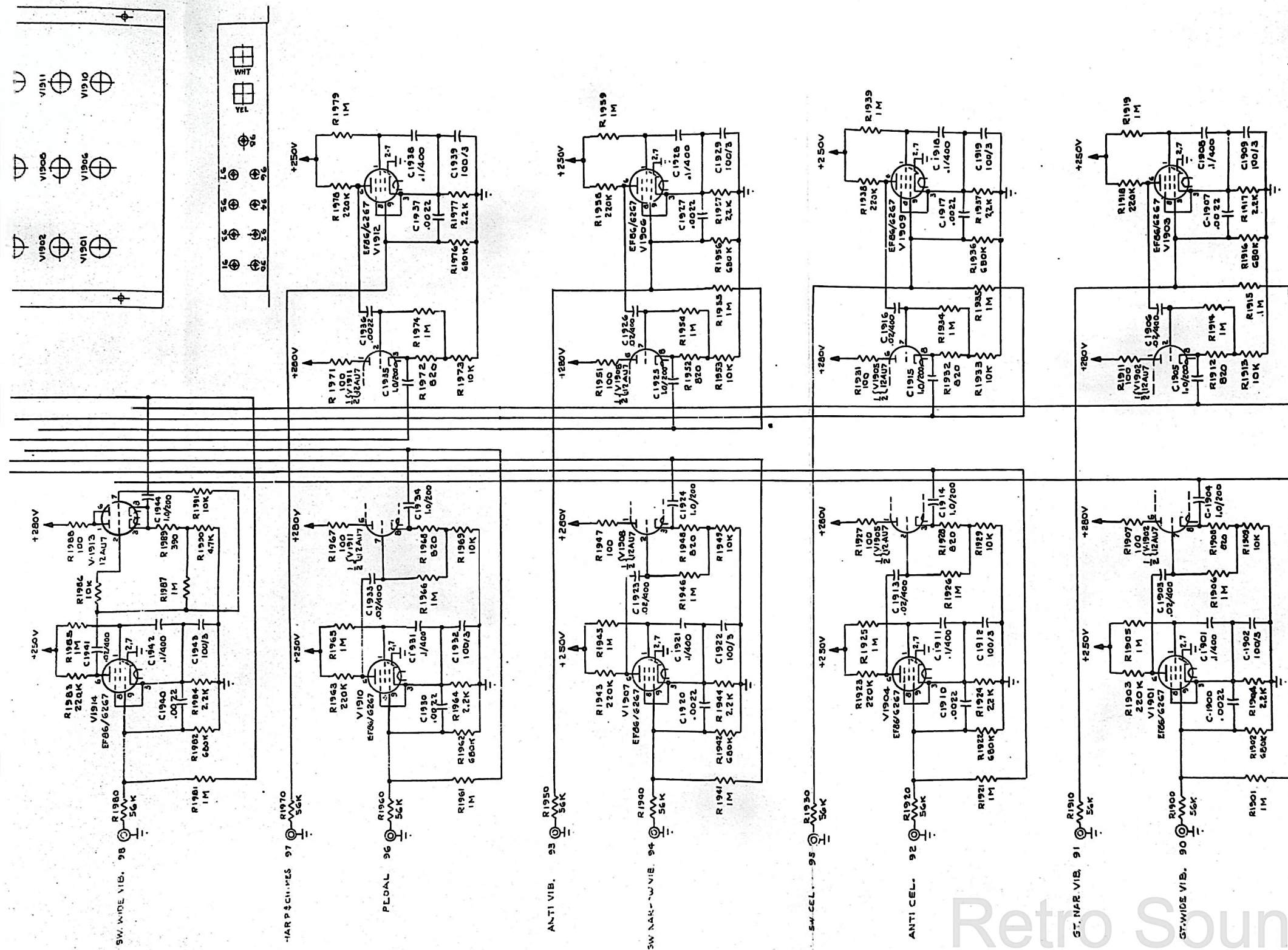
\* LEAD FROM MAGNET COIL TO CONNECT TO CONDENSER LEAD TERMINAL AS NOTED





**PAGE 16**







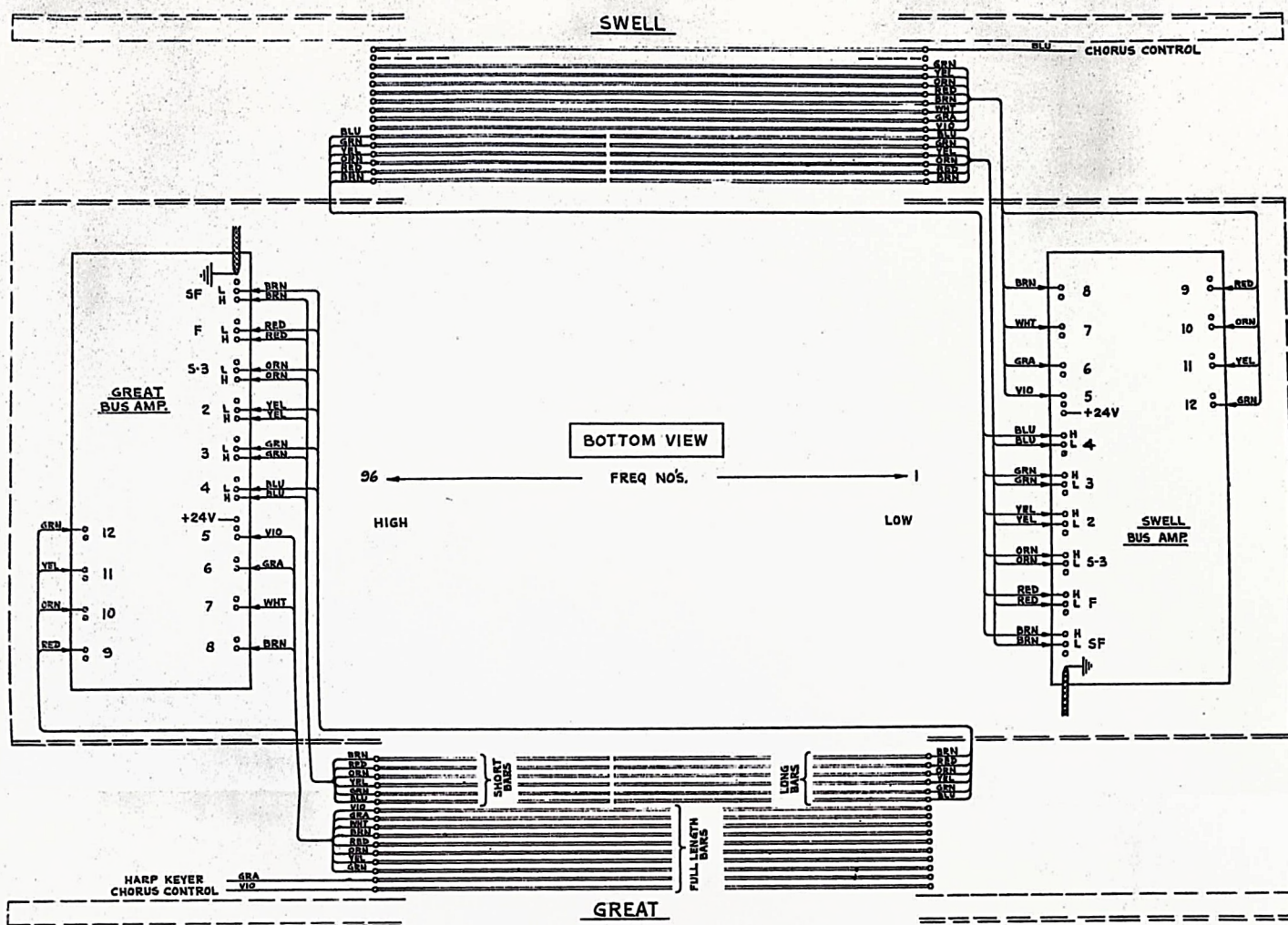


FIGURE 7 Bus Wiring Diagram Manual Relay Assembly

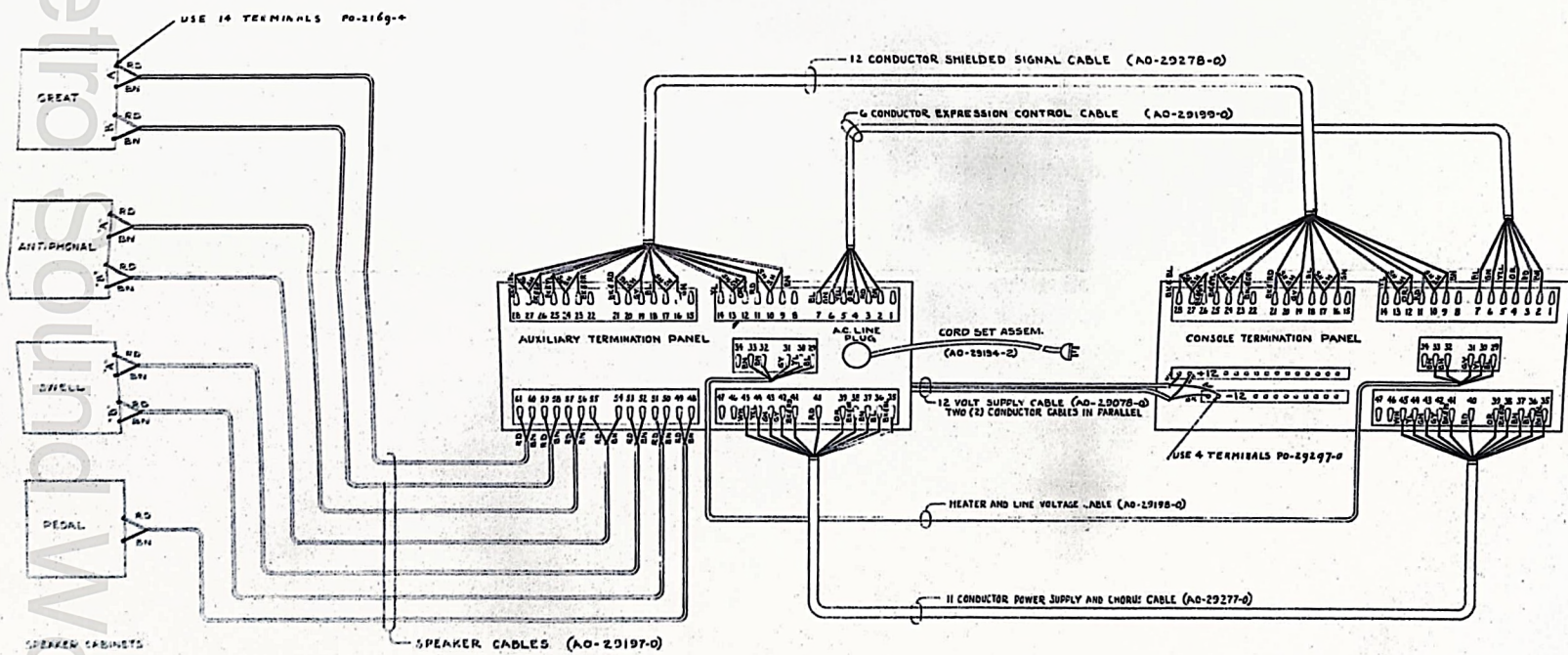
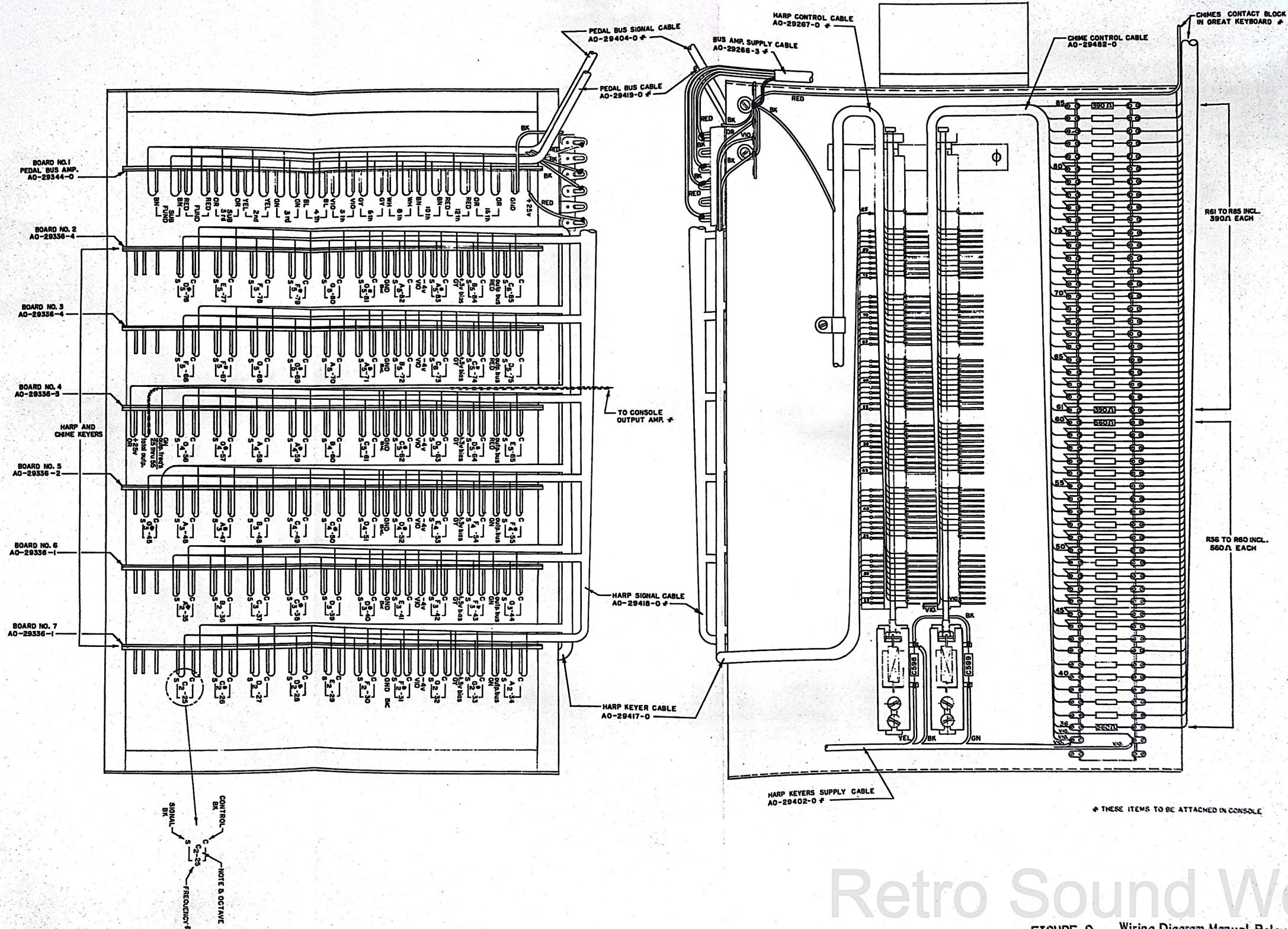


FIGURE 8 System Wiring Diagram





Retro Sound Works

FIGURE 9 Wiring Diagram Manual Relays



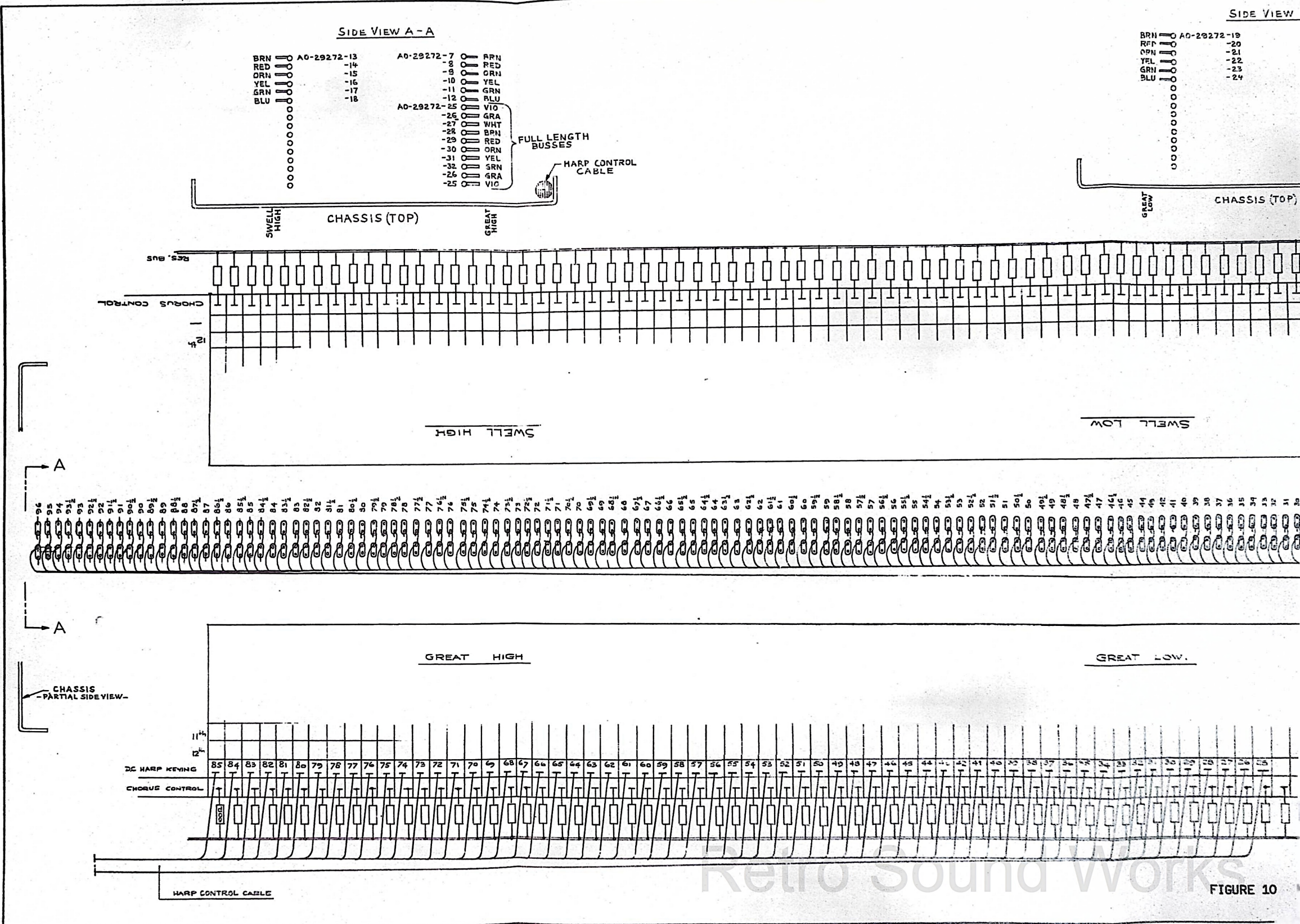
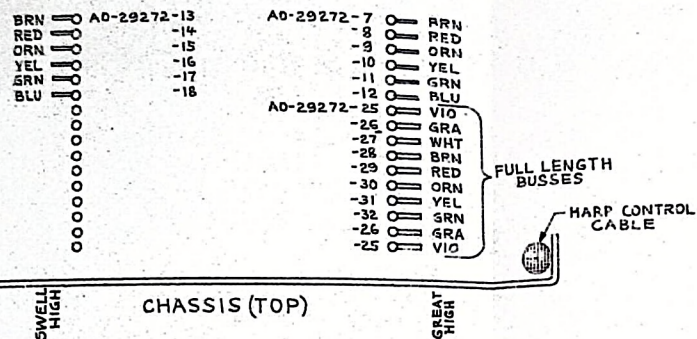


FIGURE 10



# SIDE VIEW A-A



# SIDE VIEW B-B

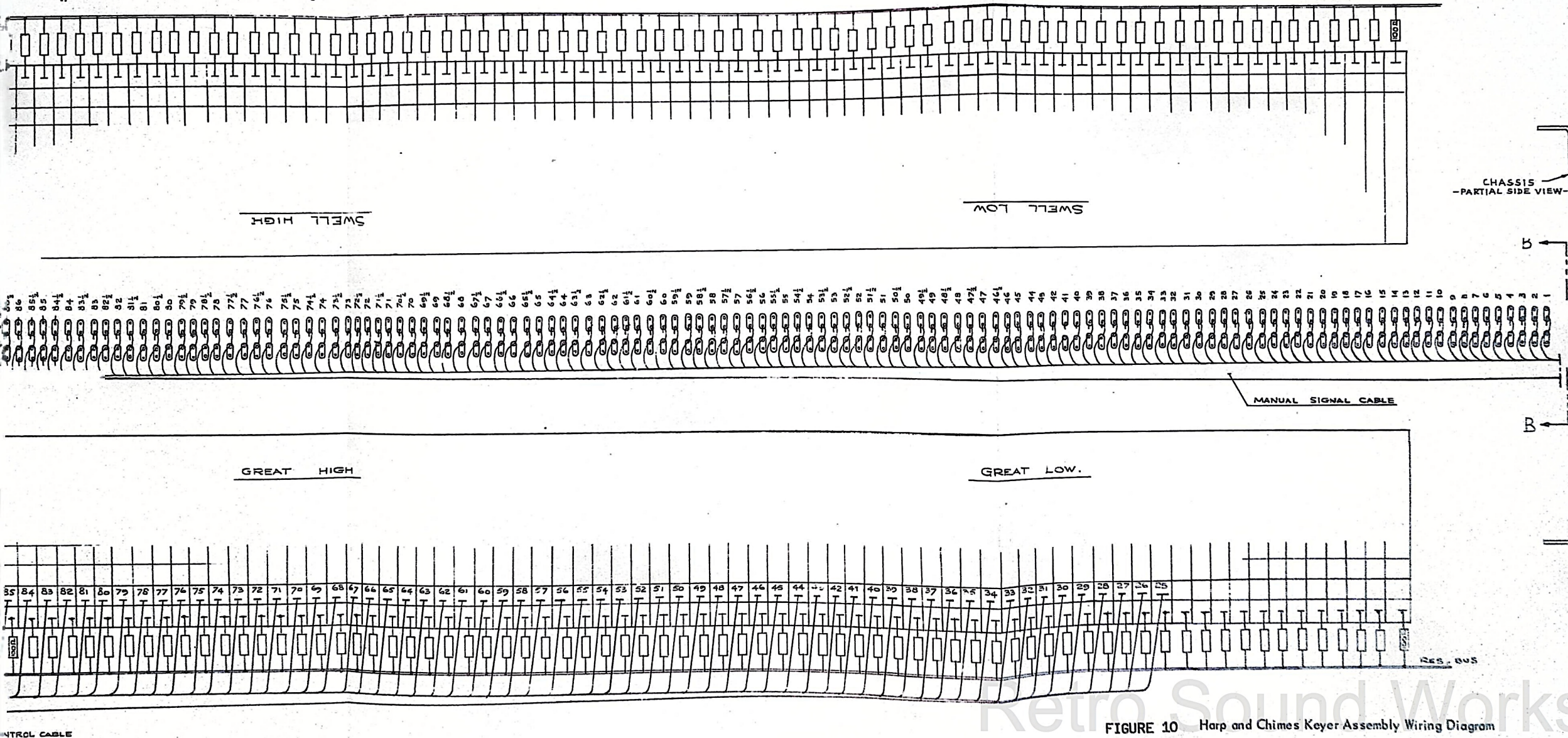
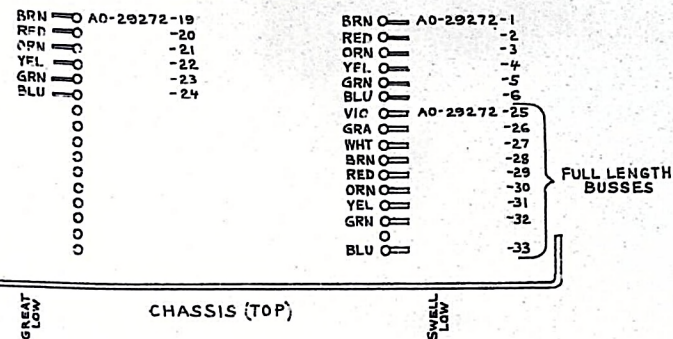


FIGURE 10 Harp and Chimes Keyer Assembly Wiring Diagram



	(A0-28074-4)										(A0-28074-5)										(A0-28074-6)										(A0-28074-7)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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[illegible]



(A0-29074-5)										(A0-29074-6)										(A0-29074-7)										(A0-29074-8)									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
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321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400
401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440
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481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640
641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680
681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720
721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760
761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800
801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840
841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880
881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920
921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960
961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000

50 1/2 Ω  
(A0-29074-5)

GREAT MANUAL  
REAR VIEW - UPSIDE DOWN

(A0-29074-7)										(A0-29074-6)										(A0-29074-5)										(A0-29074-4)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
D#	E	F	F#	G	G#	A	A#	B	C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	SUB. FUND.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
78	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	FUNDAMENTAL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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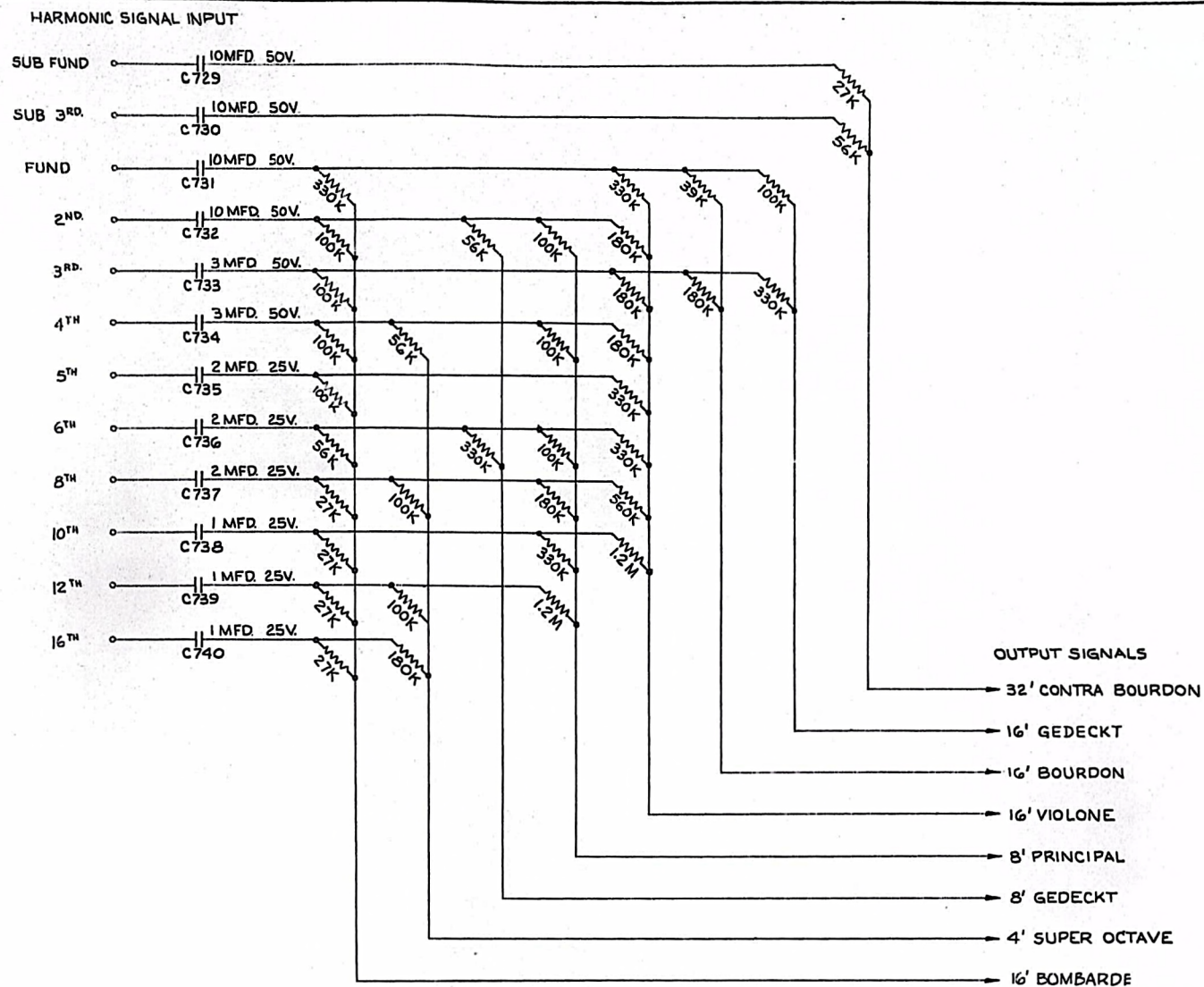


FIGURE - 16 Schematic Pedal Voice Mesh

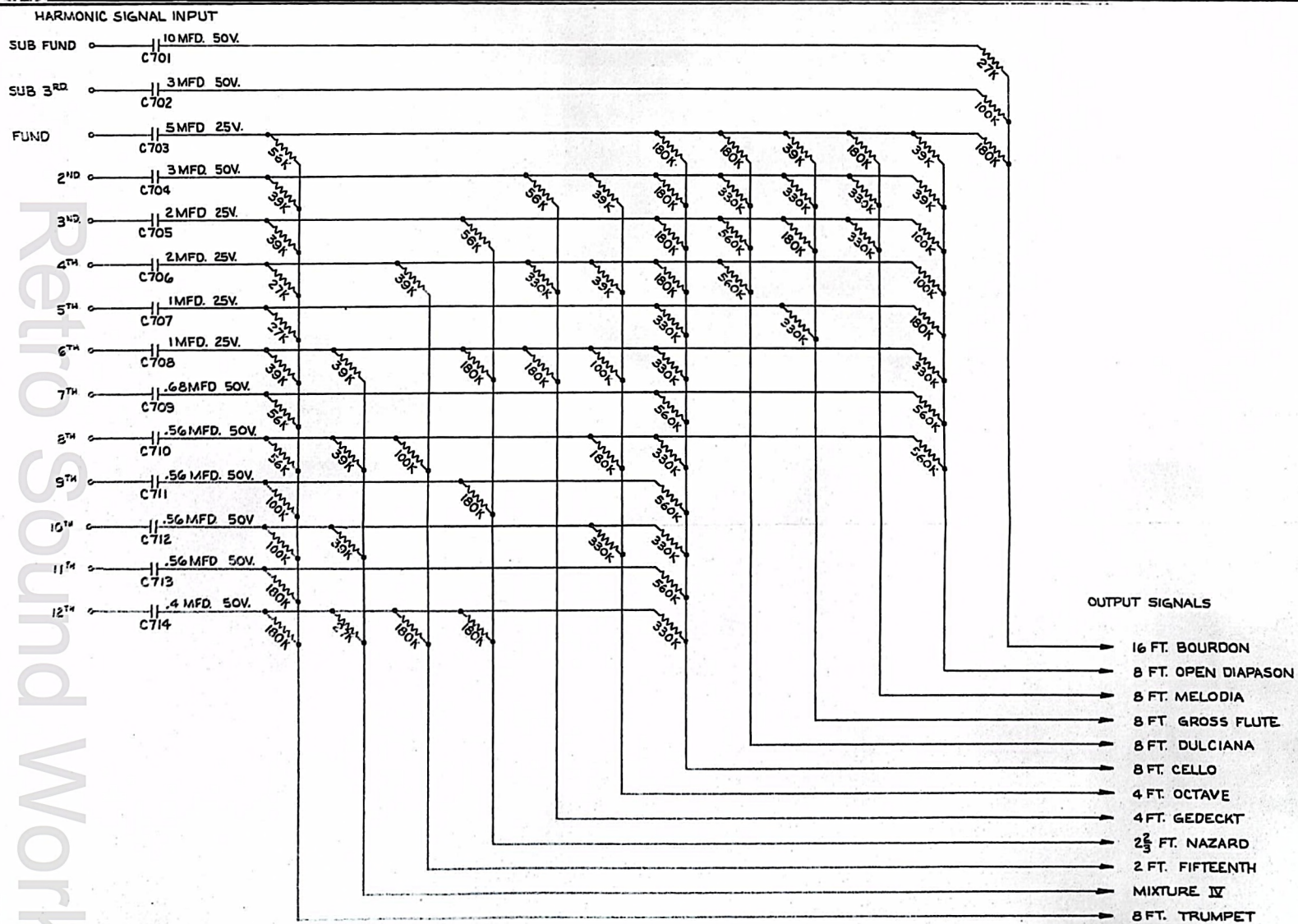
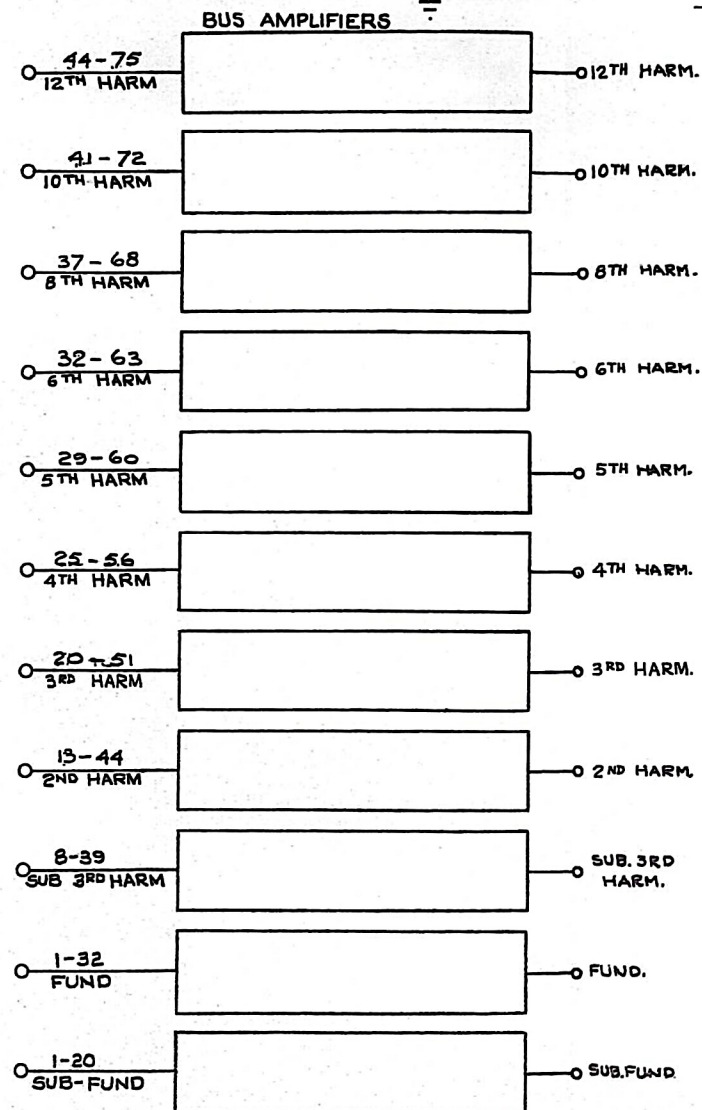
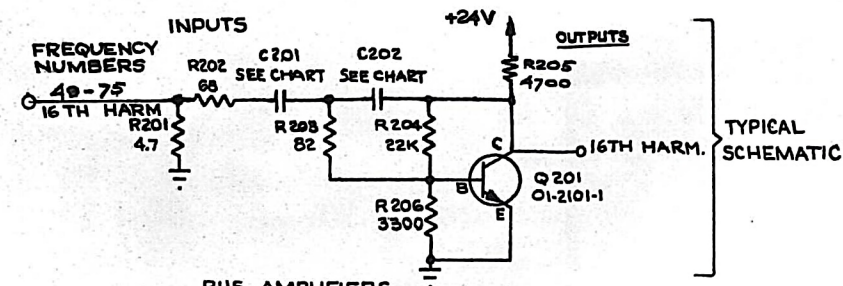


FIGURE 17 Schematic Great Voice Mesh



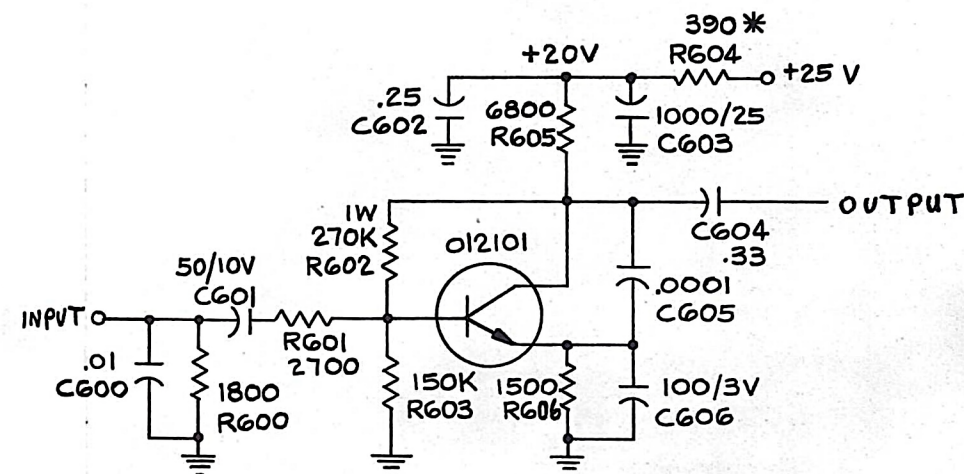


CAPACITOR VALUE CHART		
PEDAL BUS	C201	C202
16TH HARM	5	.0047
12TH HARM	5	.0047
10TH HARM	5	.0047
8TH HARM	10	.01
6TH HARM	10	.01
5TH HARM	10	.01
4TH HARM	20	.01
3RD HARM	20	.022
2ND HARM	50	.047
SUB3RDHARM	50	.1
FUND.	50	.1
SUB FUND	50	.22

NOTE .  
 1. ALL CAP. VALUES ARE IN MICROFARADS.  
 2. ALL RES. VALUES ARE IN OHMS.

FIGURE 18 Schematic Pedal Bus Amp. Assembly

\* ON SOME OF THE TABLET AMPLIFIERS R604 IS 1000 OHMS AND ON OTHERS IT IS 2200 OHMS.

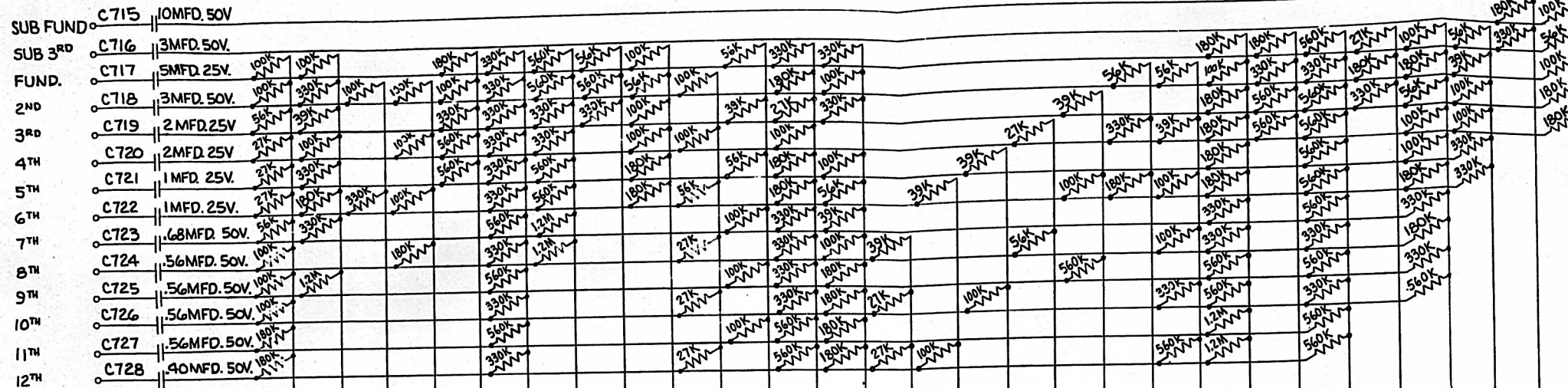


(FOR COMPONENT LOCATION REFER TO TAB. PREAMP. ASSY. DRAWING AO-29446).

FIGURE 19 Schematic Tablet Pre-Amp.



# HARMONIC SIGNAL INPUT



## OUTPUT SIGNALS

- 16' GEIGEN DIAPASON
- 16' BOURDON
- 8' DIAPASON
- 8' GEIGEN PRINCIPAL
- 8' CONCERT FLUTE
- 8' AEOLINE
- II DULCIANA CELESTE
- 8' GAMBA
- 4' OCTAVE
- 4' GEDECKT
- 2 2/3' NAZARD
- 2' FLAUTINO
- 1 2/3' TIERCE
- 1 1/3' LARIGOT
- III MIXTURE
- 8' VOX HUMANA
- 8' OBOE
- 8' CLARINET
- 4' CLARION
- 8' OPEN DIAPASON
- 8' GEDECKT
- 8' SALICIONAL
- 8' VIOLA DA GAMBA
- II GEMSHORN CELESTE
- 4' PRINCIPAL
- 4' FLAUTO D'AMORE
- 8' ENGLISH HORN
- 8' TRUMPET

Retro Sound Works

FIGURE 20 Schematic Swell and Antiphonal Voice Mes



# HARMONIC SIGNAL INPUT

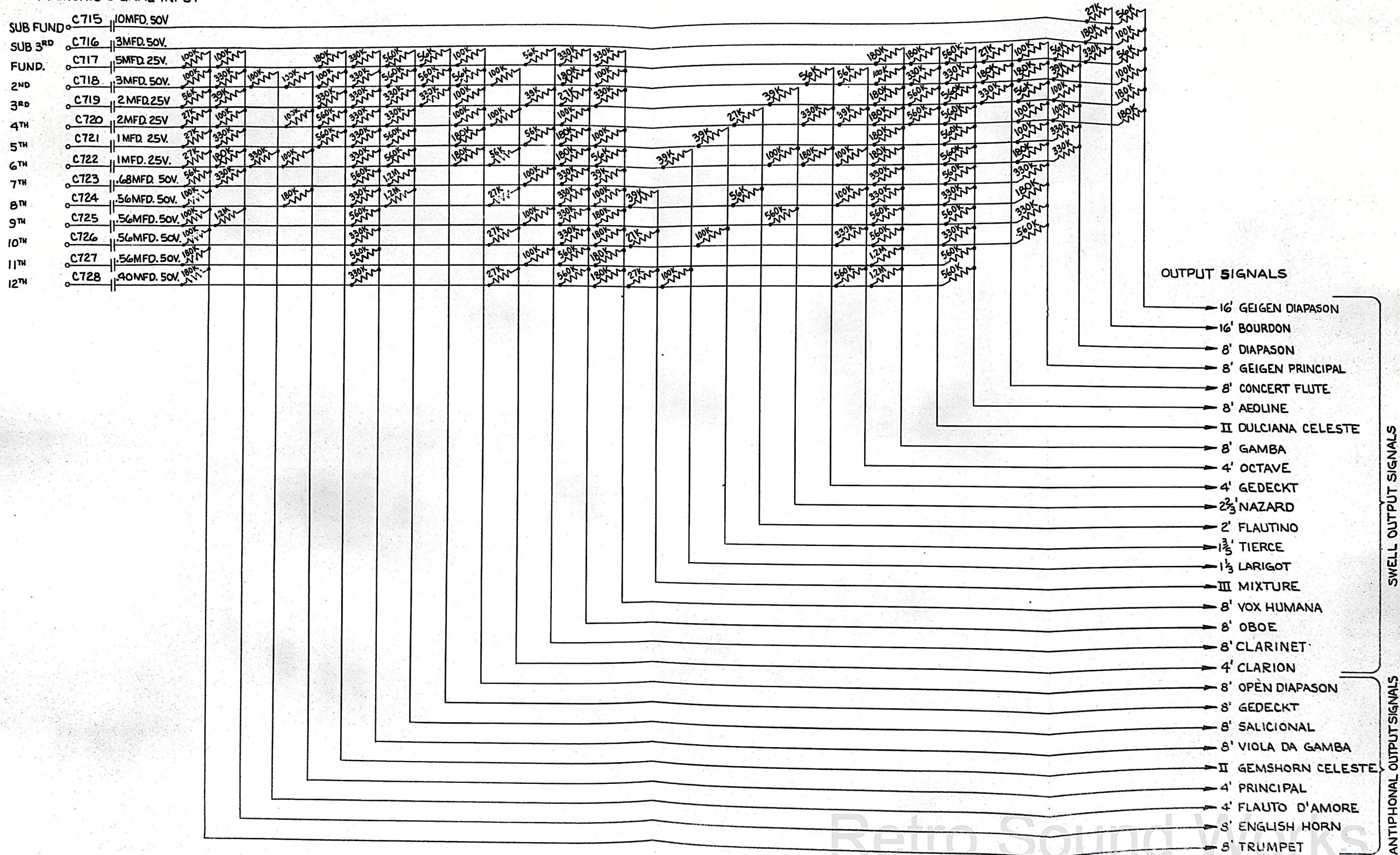
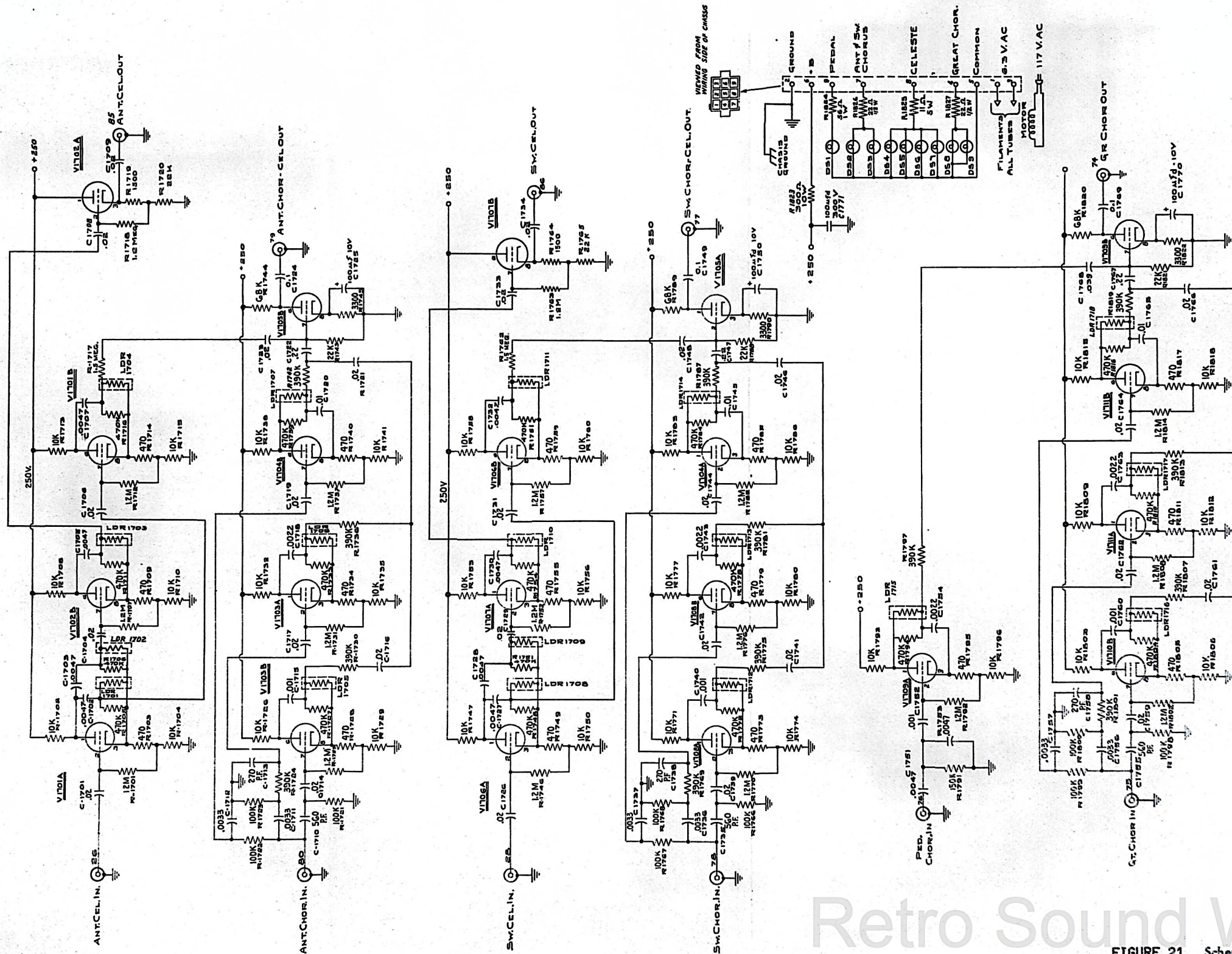


FIGURE 20 Schematic Swell and Antiphonal Voice Mesh





NOTES:

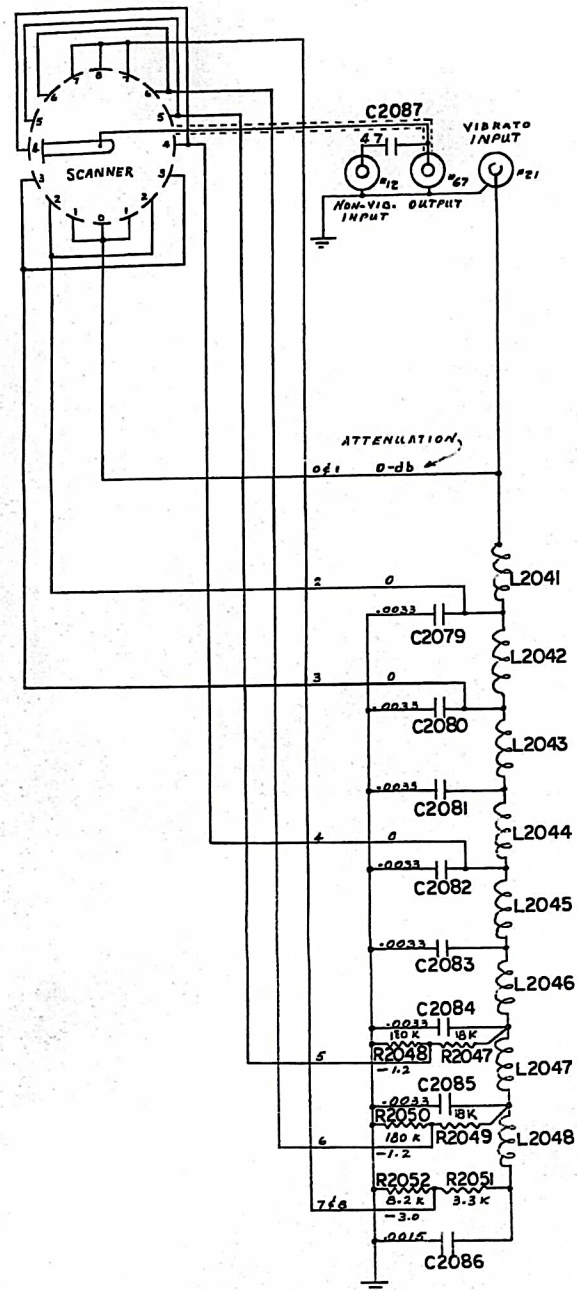
1. HIGHEST C' USED - C1771
2. HIGHEST R' USED - R1827
3. ALL RESISTORS  $\frac{1}{2}$  W UNLESS OTHERWISE SPECIFIED
4. ALL TUBES TYPE 12AU7
5. ALL LAMPS - TYPE #12

Retro Sound Works

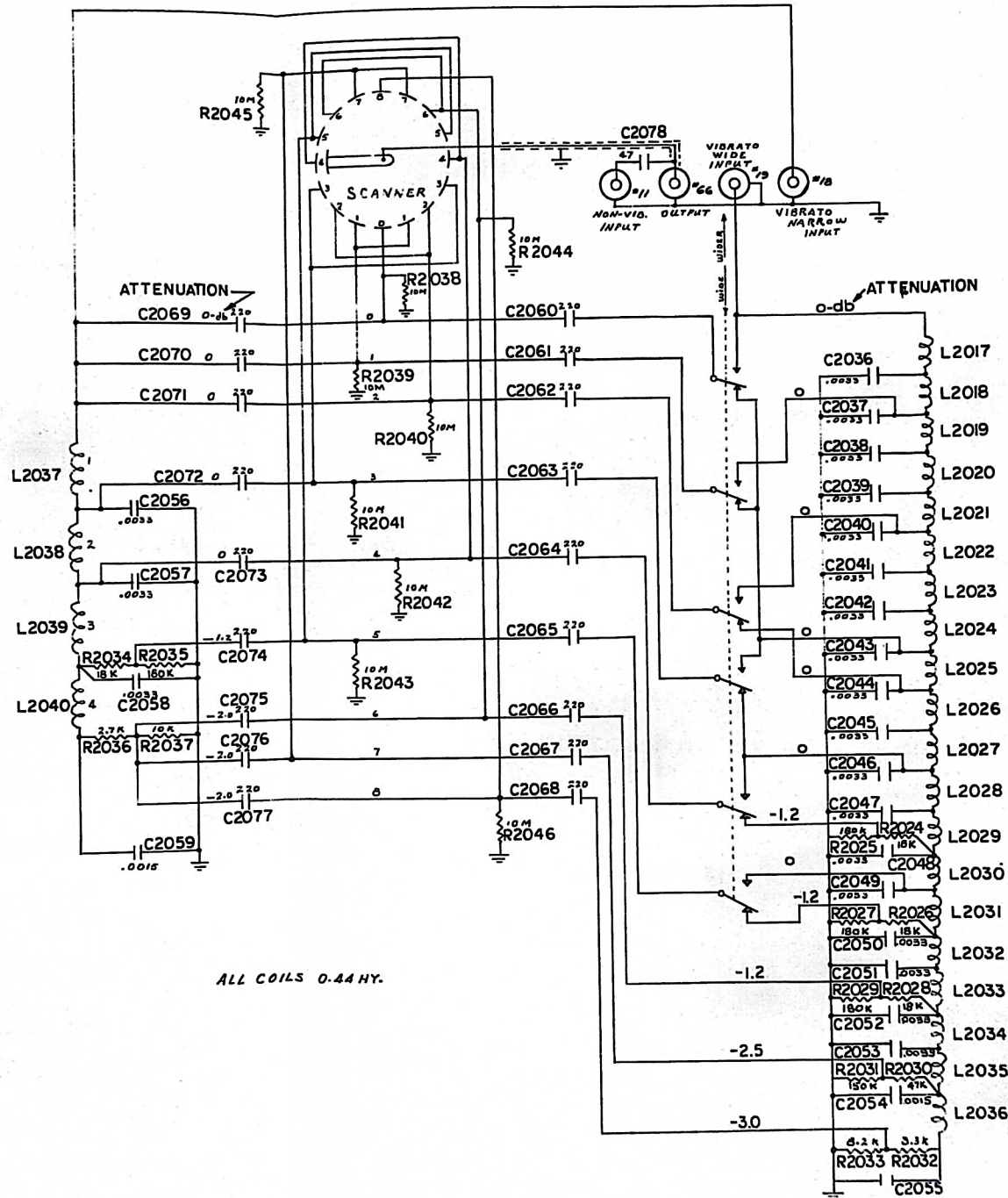
FIGURE 21 Schematic Chorus - Celeste



# ANTIPHONAL

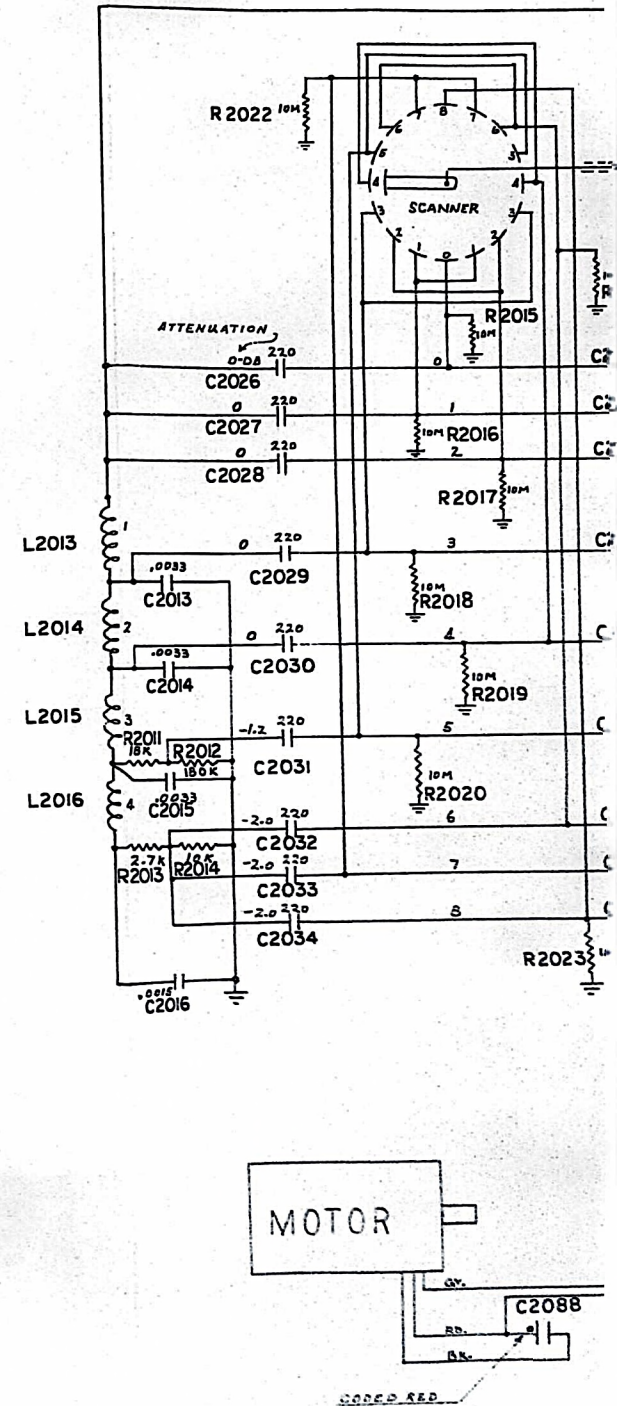


# SWELL



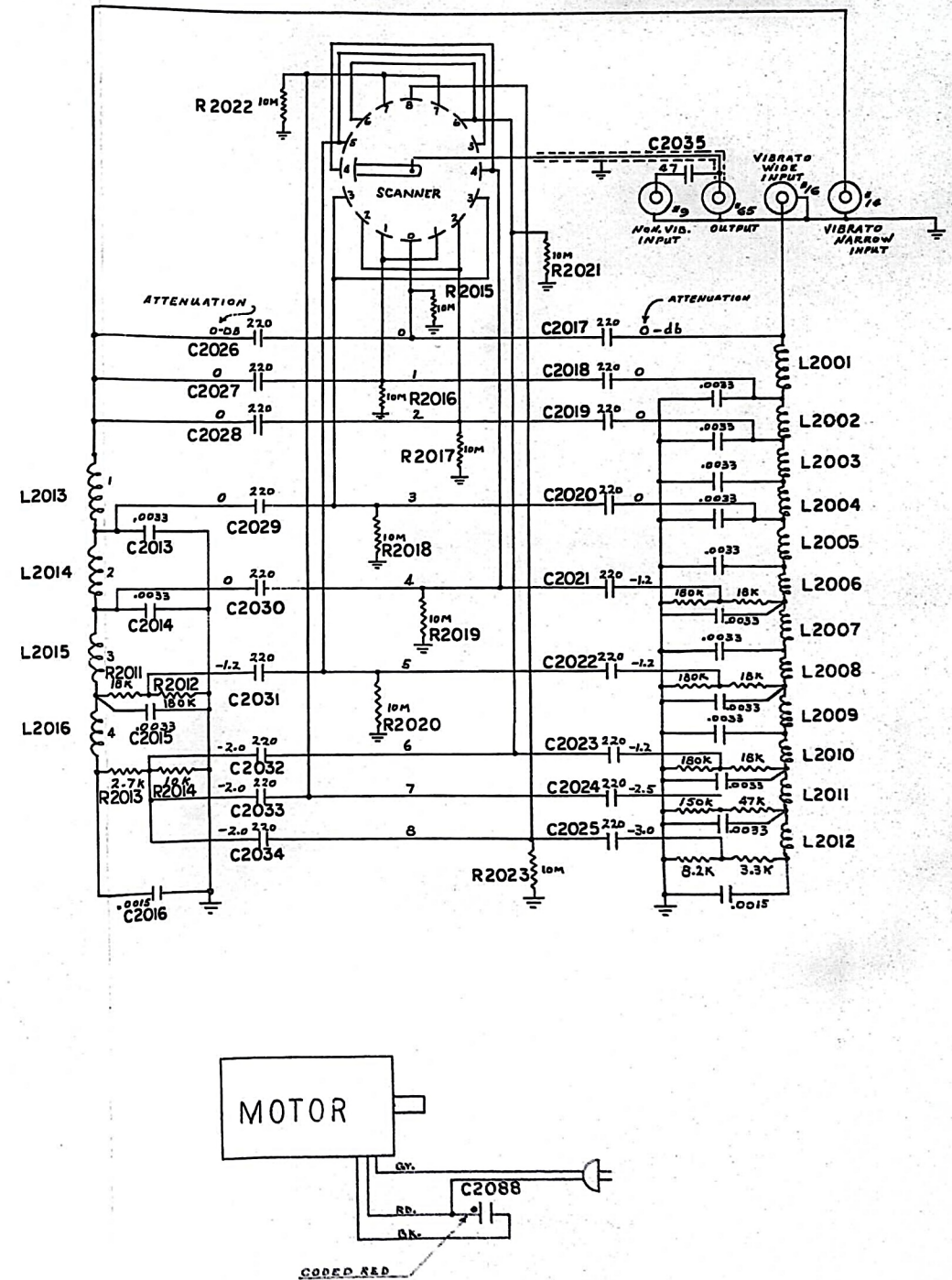
- NOTE:  
 1. HIGHEST 'R' USED R2052  
 2. HIGHEST 'C' USED C2088  
 3. HIGHEST 'L' USED L2048

# GREAT





GREAT



## Retro Sound Works



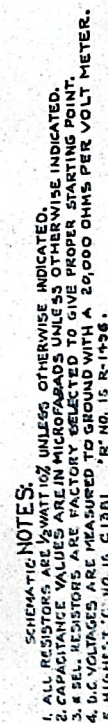
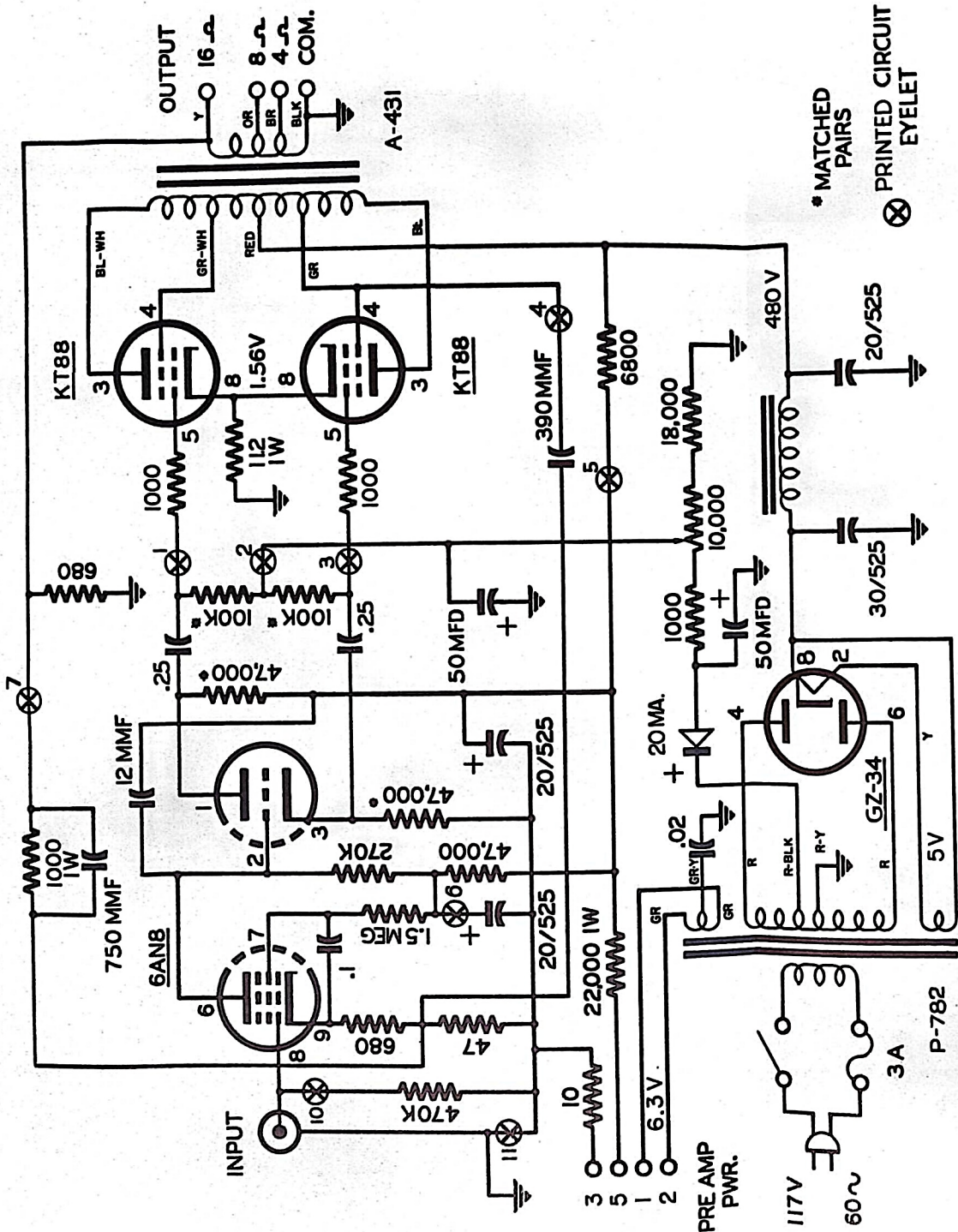


FIGURE 23 Schematic Intermediate Amplifier



# DYNAKIT MARK III 60 WATT POWER AMPLIFIER



### Voltage Check Points

Voltages have been measured with a vacuum tube volt meter. If a meter of lower impedance is used, some of the measurements will result in lower readings than those shown.

Pin #	Either KT-88	GZ-34	6AN8
1	1.56	0	*
2		490	*
3		0	*
4		475	*
5		430 ac	*
6		0	*
7	-55 **	430 ac	
8	-55 **	0	
9	1.56	490	
	--	--	1.0

Eyelet #4 475. - Eyelet #5 445 - Eyelet #6 380

\* Minor variations in current drain of the 6AN8 tube will cause large changes in electrode voltages without detrimental effect on performance. Therefore, voltage checks are not applicable at these points.




**\*\* Do not make measurements at these points with other than a vacuum tube volt meter. Variations up to 20% do not indicate malfunctioning as long as readings at both tubes are the same.**





FIGURE 25 AO-58-1 Dynakits

### VOLTAGE TEST POINTS

Pin #	Any EL-34	GZ-34	Either 7199	Capacitor lug #		
1	1.56	-	*	1	415	
2		435	*	2	435	
3		410	-	*	3	305
4		415	360 ac		4	375
5		-32**	-		1.0	
6		-32**	360 ac		0	
7		-	*	<b>Selenium rectifier</b>		
8	1.56	435	*	Bottom (+) lug	50 ac	
9	-	-	*	Top (-) lug	-65 dc	

\*Measurements at these points vary from tube to tube and do not indicate whether performance is normal.

**\*\*Measurements at these points can only be made with a vacuum tube voltmeter. The two tubes in a pair should have identical readings.**

## Selenium rectifier

Bottom (+) lug 50 ac

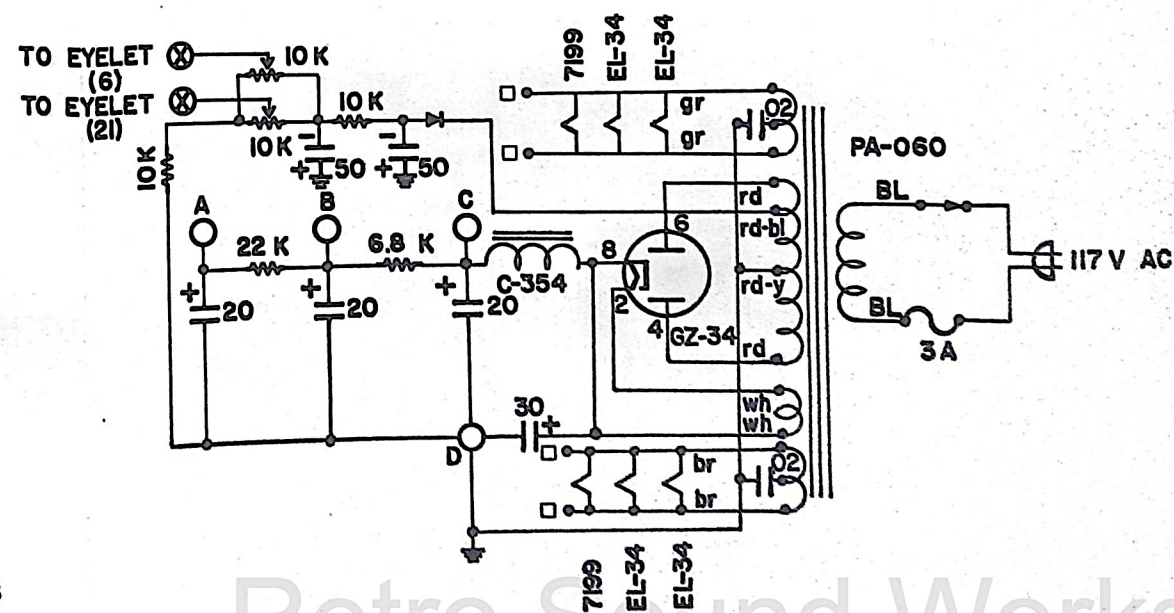
Top (-) lug -65 dc

Printed circuit

**Eyelets #3 and #18**

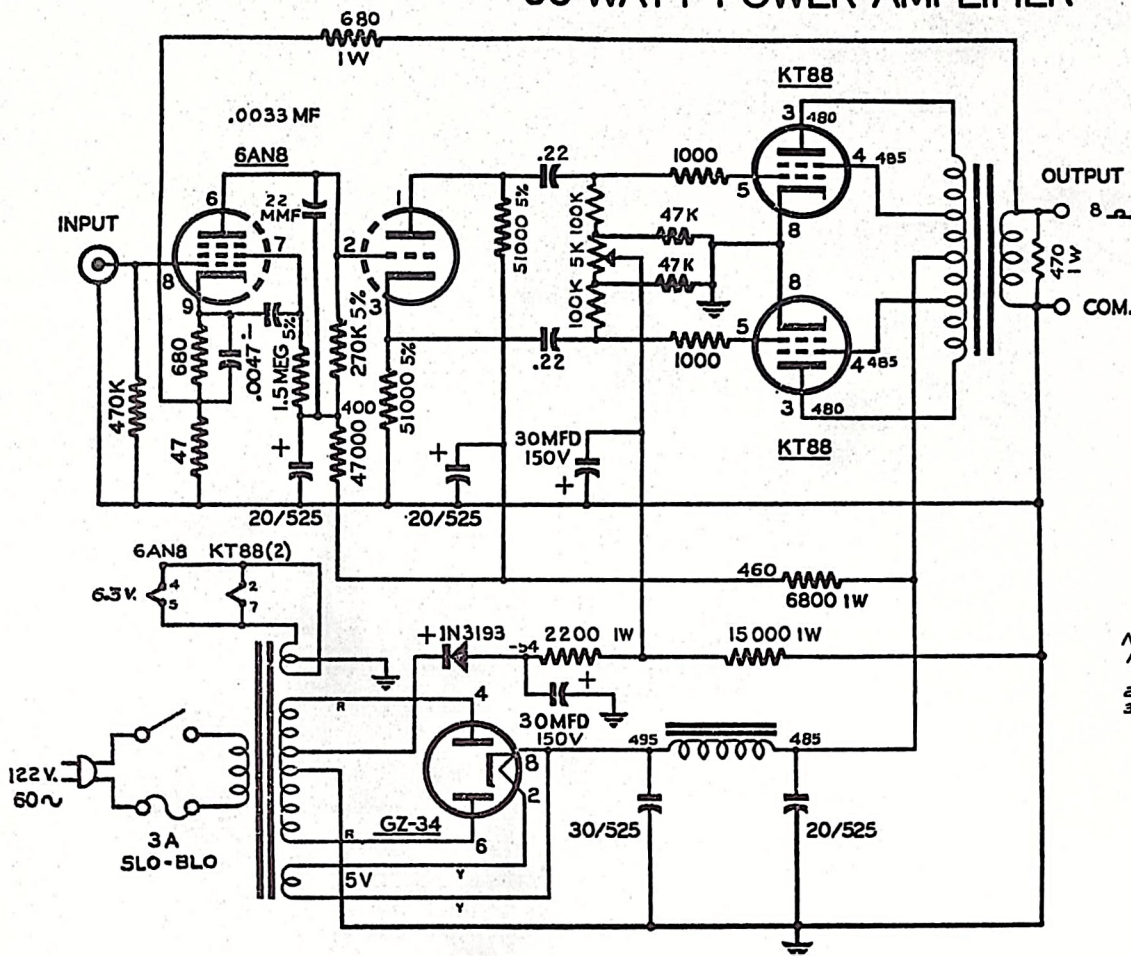
(no preamp connected)

370 volts dc





## 60 WATT POWER AMPLIFIER

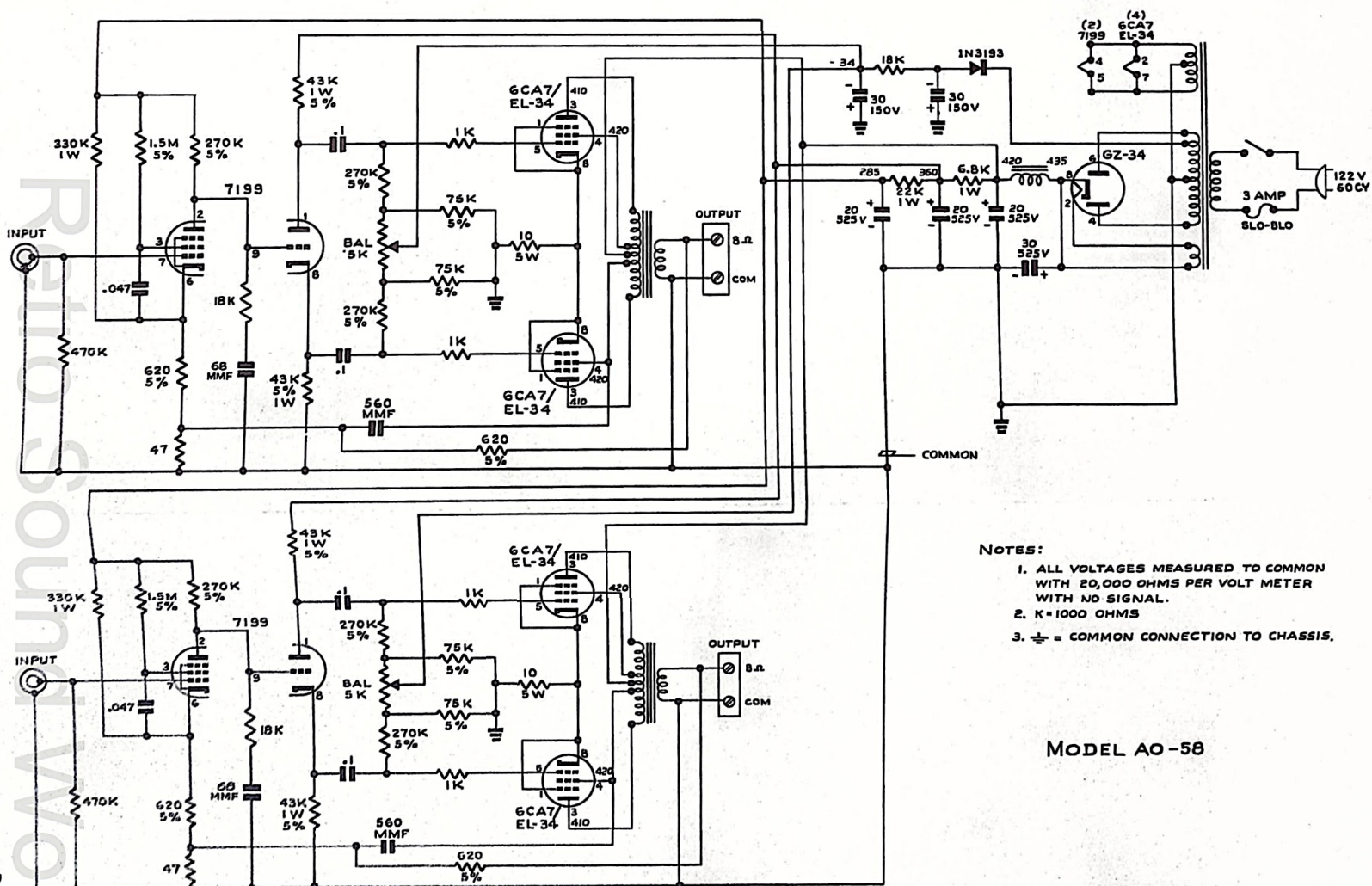


**NOTES:**

1. ALL VOLTAGES MEASURED TO COMMON WITH 20,000 OHMS PER VOLT METER NO SIGNAL
2.  $K = 1000$  OHMS
3.  $\perp$  = COMMON CONNECTION TO CHASSIS

**MODEL AO-59-1**

**FIGURE 26. Monaural Output Amplifier Model – AO-59-1**



**NOTES:**

1. ALL VOLTAGES MEASURED TO COMMON WITH 20,000 OHMS PER VOLT METER WITH NO SIGNAL.
2. K=1000 OHMS
3.  $\frac{1}{2}$  = COMMON CONNECTION TO CHASSIS.

MODEL AO-58

**FIGURE 27 Stereo Output Amplifier Model – AO-58 – 1**